REPORT RESUMES

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PSYCHOLOGICAL AND EDUCATIONAL FACTORS IN TRANSFER OF TRAINING. SECTION I, FINAL REPORT.
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DATA ABOUT TRANSFER OF TRAINING AS BOTH A PSYCHOLOGICAL AND AN EDUCATIONAL PROCESS WERE CONSOLIDATED AND EVALUATED. THIS DOCUMENT (SECTION I OF A FINAL REPORT) PROVIDES A SUMMARY OF APPROXIMATELY 1,700 ARTICLES IN THE LITERATURE UNDER THE AUTHOR'S TAXONOMIC SYSTEM WHICH IS UNDER DEVELOPMENT. THE PURPOSE OF THIS SUMMARY IS TO FACILITATE THE PROCESS OF RELATING LABORATORY RESEARCH ON TRANSFER TO EDUCATIONAL PROBLEMS. ALSO SUMMARIZED WERE OVER 200 PRINCIPLES OF TRANSFER (REFERENCED TO A BIBLIOGRAPHY, ED 010 113), AS WELL AS STUDIES DONE AT THE UNIVERSITY OF ILLINOIS ON PROBLEMS OF TRANSFER OF TRAINING. THE BIBLIOGRAPHY REPRESENTED SECTION 2 OF THE REPORT. (GD)

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TRL

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TRAINING RESEARCH LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

PSYCHOLOGICAL AND EDUCATIONAL FACTORS IN TRANSFER OF TRAINING

SECTION I
FINAL REPORT
JULY 1966

PROJECT DIRECTOR

LAWRENCE M. STOLUROW,
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Foreword

Research conducted under contract (USOE 4-20-002) was an extension of research initiated under an earlier contract (USOE 2-20-003).

An initial report on work done under the present contract appeared in the last quarterly report of Contract 2-20-003, issued in September, 1964. That report (Quarterly Reports 8 and 9) describes work done from April until June, 1964, under Contract 2-20-003 and also research conducted from July until September, 1964, under Contract 2-20-002. At that time it was assumed that the earlier contract number would be retained. This report summarizes the work accomplished through June, 1966. This is, in effect, a report of the status of the Principal Investigator's projected 10-year project. It summarizes over 1,700 articles in the literature under the author's taxonomic system which is under development. Its purpose is to facilitate the process of relating laboratory research on transfer to educational problems. Toward this end the report also summarizes over 200 principles of transfer (Section I), and references these to the bibliography (Section II). The report also summarizes studies done at the Training Research Laboratory on transfer of training problems. Many of these original investigations were done as theses and dissertations.

Lawrence M. Stolurow

CHAPTER 1

THE NATURE OF THE PROJECT

Despite more than 60 years of research on transfer[1] there is little definitive information or explicit guidance to offer either the course developer, the curriculum builder or the media specialist. The need for information about transfer is critical for the efficient planning of lessons, courses, curricula and educational media.

This project was developed to consolidate existing information about transfer as both a psychological and an educational process and to develop new information from a continuing research program. It was designed to help solve two problems: a lack of basic information about transfer and the failure of existent information to be linked to either the educational or the training-decision processes to which it can and should contribute. To accomplish this program of work the project was divided into two phases.

Phase I

Phase I of this project had the following objectives. One was to develop hypotheses about the nature of transfer and variables affecting it. In doing this a preliminary evaluation of available experimental and theoretical studies of transfer was accomplished in a preliminary manner along with the compilation of bibliographies of research and theory. These bibliographies include the relationships between learning and transfer, the relationships between transfer, abilities, and aptitudes and the relationships between transfer and problem solving. A second objective was to formulate principles of transfer as they relate to particular educational media, methods and practices. A third was to conduct the preliminary transfer studies appropriate and necessary to determine the feasibility of particular research applications of the new media. A fourth was to formulate plans for a research program designed to determine the relationship of transfer of training to educational processes and media. This research would be carried out during Phase II.

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[1] Thorndike's and Woodworth's study was done in 1901.

Phase II

Phase II comprises two objectives. One is the conducting of research on transfer of training in relation to educational processes and the media used to develop those processes. Another is the preparing of reports and manuscripts for publication based upon the work of both phases.

CHAPTER II

TRANSFER OF TRAINING REFERENCE CATEGORIES AND PARADIGMS

The following set of reference categories was developed from a review of the literature on transfer of training. It is intended to serve two functions: (1) to provide a framework for summarizing the existing literature, and (2) to aid in planning the research for Phase II of the present project.

The reference categories are divided into six main topics whose headings are indicated by roman numerals. Each of these topics represents some aspect of a transfer of training study; e.g., its design, task characteristics, findings, etc. Each main topic, therefore, and one or more subtopics, should be applicable to a transfer study, thus establishing the framework for reducing it, or any other such study, to a summary code.

The advantages of such a comprehensive coding system for purposes of categorization of transfer studies become evident from a consideration of the main topics and their delineation into subtopics, any one of which may act as a possible category to be carried out across all appropriate studies. In effect, because of the number and specificity of topics, almost any desired aspect of a study can be categorized. This coding system, then, facilitates both a thorough summary of any one transfer study or a many-faceted classification system of all such studies.

The code sequence (II.B.2., for example) represents either a part of a summary code of one particular study or a category under which all studies that deal with this factor can be grouped. The sequence parenthesized

above is interpreted as follows: the roman numeral designates a main topic, Mechanisms; A is a subdivision of Mechanisms, Stimulus Generalization.

DESCRIPTIVE CATEGORIES

- I. Type of Article
  - A. Theoretical
  - B. Experimental
    - 1. Human
    - 2. Animal
  - C. Survey
  - D. Other

- II. Mechanisms
  - A. Stimulus Generalization
  - B. Extinction
  - C. Response Generalization
  - D. Mediation
  - E. Discrimination
  - F. Warm-up
  - G. Learning to Learn

- III. Method
  - A. Experimental Designs (Paradigms, Table 1)
    - 1. Fore- and After-
      - a. Design A
      - b. Design B

2. Successive Practice
    a. Design C
    b. Design D
    c. Design E
    d. Design F
    e. Design G
    f. Design H
    g. Other
3. Mediation
    a. 3-stage
    b. 4-stage

B. Performance Standards or Criteria
1. Partial
2. Mastery
3. Overleaning

C. Measurement
1. Judgments
2. Savings
3. Recall
4. Recognition
5. Successes
6. Latency

IV. Task Characteristics

- **A. Training Task***
- **B. Transfer Task***
  - **1. Intra-Task**
    - **a. Stimulus Characteristics**
      - **(1) Number of Stimuli**
        - **(a) One Stimulus**
          - **[1] Classical Conditioning**
          - **[2] Other**
        - **(b) Two or More Stimuli**
          - **[1] The Sequence of the Stimuli Vary From One Task to the Next**
          - **[2] The Sequence of the Stimuli Does Not Vary From One Task to the Next**
      - **(2) Qualitative Relationship Between Task Stimuli**
        - **(a) Homogeneous (Same)**
        - **(b) Heterogeneous (Different)**
      - **(3) Meaningfulness of Stimuli**
        - **(a) Have Dimension(s) Which Can be Conventionally Ordered - Have Associative Significance for Subject**
        - (b) Have Dimension(s) Which Can be Conventionally Ordered - Have no Associative Significance for Subject
        - (c) Have no Conventionally Orderable Dimension - Have Associative Significance for Subject
        - (d) Have no Conventionally Orderable Dimension - Have no Associative Significance for Subject

***Code both A and B in terms of Divisions 1, 2, and 3 and their subpoints.**

b. Response Characteristics
  - (1) Number of Responses
    - (a) One Response
    - (b) Two or More Responses
      - [1] The Sequence of the Responses Vary From One Task to the Next
      - [2] The Sequence of the Responses Does Not Vary From One Task to the Next
  - (2) Qualitative Relationship Between Task Responses
    - (a) Homogeneous
    - (b) Heterogeneous
  - (3) Meaningfulness of Responses
    - (a) Have Dimension(s) Which can be Conventionally Ordered - Have Associative Significance for Subject
    - (b) Have Dimension(s) Which Can be Conventionally Ordered - Have no Associative Significance for Subject
    - (c) Have no Conventionally Orderable Dimension - Have Associative Significance for Subject
    - (d) Have no Conventionally Orderable Dimension - Have no Associative Significance for Subject

c. Stimulus-Response Linkage(s)

2. Inter-Task

a. Proaction
  - (1) Neutral
  - (2) Facilitation
  - (3) Interference

- b. Retroaction
    - (1) Neutral
    - (2) Facilitation
    - (3) Interference
- c. Stimulus Characteristics
    - (1) Number of Stimuli
        - (a) One Stimulus
            - [1] Classical Conditioning
            - [2] Other
        - (b) Two or More Stimuli
            - [1] The Sequence of the Stimuli Vary From One Task to the Next
            - [2] The Sequence of the Stimuli Does Not Vary From One Task to the Next
    - (2) Qualitative Relationship Between Task Stimuli
        - (a) Homogeneous
        - (b) Heterogeneous
    - (3) Meaningfulness of Stimuli
        - (a) Have Dimension(s) Which Can be Conventionally Ordered - Have Associative Significance for Subject
        - (b) Have Dimension(s) Which Can be Conventionally Ordered - Have No Associative Significance for Subject
        - (c) Have No Conventionally Orderable Dimension - Have Associative Significance for Subject
        - (d) Have No Conventionally Orderable Dimension - Have No Associative Significance for Subject

- (4) Stimulus Discrimination
- (5) Affective Reaction to Stimulus
- (6) Transfer as a Function of Frequency of Stimulus Presentation
- (7) Transfer as a Function of Stimulus Sequence

d. Response Characteristics

- (1) Number of Responses
    - (a) One Response
    - (b) Two or More Responses
        - [1] The Sequence of the Responses Vary From One Task to the Next
        - [2] The Sequence of the Responses Does Not Vary From One Task to the Next
- (2) Qualitative Relationship Between Task Responses
    - (a) Homogeneous
    - (b) Heterogeneous
- (3) Meaningfulness of Responses
    - (a) Have Dimension(s) Which Can be Conventionally Ordered - Have Associative Significance for Subject
    - (b) Have Dimension(s) Which Can be Conventionally Ordered - Have No Associative Significance for Subject
    - (c) Have No Conventionally Orderable Dimension - Have Associative Significance for Subject
    - (d) Have No Conventionally Orderable Dimension - Have No Associative Significance for Subject

- e. Stimulus-Response Linkage(s)
  - (1) Cue Reversal
  - (2) Response Reversal
  - (3) Both (a) and (b)
  - (4) Reversal Shift
- f. Content Conditions
  - (1) Degree of Similarity
  - (2) Degree of Meaningfulness
  - (3) Common Elements
  - (4) Degree of Difficulty
  - (5) Dimension Shifts
- g. Temporal Factors
  - (1) Duration of Transfer Effects - Facilitation or Interference in Learning of Subsequent Experimental Tasks
  - (2) Time Interval
    - (a) Between Training Task and Interpolated Activity
    - (b) Between Training Task and Test of Transfer

3. Other

V. Subject Factors

   A. Individual Differences in Entering Behavior

      1. Age

      2. Sex

      3. Motivation

      4. Level of Training and/or Ability

      5. Anxiety Level

      6. Verbal Habits

      7. Level of Mentality, Normal and/or Retarded

   B. Experimentally Shaped Individual Differences - Pretraining

      1. Instructions

      2. Specific Practice in Task I

         a. Same Task as Used in Measuring Transfer (Retroaction)

            (1) Amount of Practice

            (2) Type of Practice

            (3) Conditions of Practice

         b. Different Task Than That Used in Measuring Transfer (Proaction)

            (1) Amount of Practice

            (2) Type of Practice

            (3) Conditions of Practice

      3. Non Specific Practice in Task I

         a. Same Task as Used in Measuring Transfer

            (1) Amount of Practice

            (2) Type of Practice

            (3) Conditions of Practice

- b. Different Task Than That Used in Measuring Transfer
    - (1) Amount of Practice
    - (2) Type of Practice
    - (3) Conditions of Practice

VI. Results

- A. Variables
    - 1. Difference
    - 2. No Difference
- B. Groups
    - 1. Difference
    - 2. No Difference
- C. Interaction Effects

Table 1

Paradigms for the Study of Transfer

Type	Design	Group	Ref. Exper.	Conditions
Fore- and after-test				
	A (Woodworth Plan 1)	E 1. Fore-test in T2 2. Practice in Tl 3. After-test in T2		Condition 3--Tl
		C 1. Fore-test in T2 2. Practice in Tl'		Condition 3--Tl' is non-specific activity or is similar to TL but irrelevant to T2. (NOTE: See, also, Design E).
	B (Woodworth Plan 2)	E only 1. Practice in Tl 2. After-test in T2		Condition 1--Tl is equated to T2 by previous standardization so that first trial of Tl is equivalent to a fore-test in T2

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive practice				
	C (Woodworth Plan 3; Murdock Design I)	*E* only		
		1. Learn T1 2. Learn T2	Gaydos, 1956	Condition 1--T1 equated to T2 by previous standardization
	D (Murdock Design II)	*E* only		
		1. Learn T1 2. Interval 3. Learn T2	Andrews, Shapiro and Cofer, 1954	Condition 1--T1 equated to T2 by previous standardization
				Condition 2--Time interval or interpolated activity between T1 and T2
	E (Woodworth Plan 4; Murdock Design III)	*E*		
		1. Learn T1 2. Learn T2		
		C		
		1. Learn T1' 2. Learn T2	Spiker, 1956	Condition 3--T1' is a non-specific preliminary activity or similar to TL but irrelevant to T2. (NOTE: This design differs from Design A in that there is no fore-test on T2.

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
	F (Woodworth Plan 5)	E-1		
		1. Learn T1 2. Learn T2		Condition 4--Groups are pooled first for T1 learning and then T2 learning
		E-II		
		1. Learn T2 2. Learn T1		
	G (Murdock Design IV)	E		
		1. Learn T1 2. Learn T2	Maltzman and Brooks, 1956	Condition 6--T2 and T2' are similar.
		C		
		1. Learn T1 2. Learn T2'		
	H (Murdock Design V)	E		
		1. Learn T1 2. Learn T2	L'Abate, 1956	Condition 5--T1 and T1' are similar
		C		
		1. Learn T1' 2. Learn T2'		Condition 6--T2 and T2' are similar

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice				
	Jenkins (1959,1963) Three-stage Paired Associate Learning Mediation Paradigm 1 (Simple Chaining)	E 1. Learn or culturally acquire: A-B 2. Learn or culturally acquire: B-C 3. Test: A-C	Kjeldergaard and Horton (196) Cramer and Cofer (1960)	A-B learned or given for half of test List's A-C pairs. A-B not learned or given for half of test list's A-C pairs. Each S own control.
		C 1. Learn or culturally acquire:B-C 2. Test: A-C		
	Jenkins (1959, 1963) Three-stage Mediation Paradigm 2 (Simple Chaining)	E 1. Learn or culturally acquire: B-C 2. Learn or culturally acquire: A-B 3. Test: A-C	Kjeldergaard and Horton (1960) Cramer and Cofer (1960)	B-C learned or given for half of test list's A-C pairs. B-C not learned or given for half of test list's A-C pairs. Each S own control.
		C 1. Learn or culturally acquire: A-B 2. Test: A-C		

Table 1 (Continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins (1959,1963) Three-stage Paired Associate Learning Mediation Paradigm 3 (Reverse Chaining)	E 1. Learn or culturally acquire: B-A 2. Learn or culturally acquire: C-B 3. Test: A-C C 1. Learn or culturally acquire: C-B 2. Test: A-c	Kjeldergaard and Horton (1960) Cramer and Cofer, 1960	B-A learned or given for half of test list's A-C pairs. B-A not learned or given for half of test list's A-C pairs. Each S own control.
	Jenkins (1959, 1963) Three-stage Mediation Paradigm 4 (Reverse Chaining)	E 1. Learn or culturally acquire: C-B 2. Learn or culturally acquire: B-A 3. Test: A-C C 1. Learn or culturally acquire: B-A 2. Test: A-C	Kjeldergaard and Horton (1960) Cramer and Cofer 1960	C-B learned or given for half of test list's A-C pairs. C-B not learned or given for half of test list's A-C pairs. Each S own control.

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins (1959, 1963) Three-Stage Paired Associate Learning Mediation Paradigm 5 (Stimulus Equivalence)	E 1. Learn or culturally acquire: A-B 2. Learn or culturally acquire: C-B 3. Test: A-C C 1. Learn or culturally acquire: C-B 2. Test: A-C	Kjeldergaard and Horton (1960) Cramer and Cofer (1960)	A-B learned or given for half of test list's A-C pairs. A-B not learned for half of test list's A-C pairs. Each S own control.
	Jenkins (1959, 1963) Three-Stage Mediation Paradigm 6 (Stimulus Equivalence)	E 1. Learn or culturally acquire: C-B 2. Learn or culturally acquire: A-B 3. Test: A-C C 1. Learn or culturally acquire: A-B 2. Test: A-C	Kjeldergaard and Horton (1960) Cramer and Cofer (1960)	C-B learned or given for half of test list's A-C pairs. C-B not learned for half of test list's A-C pairs. Each S own control.

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins (1959, 1963) Three-Stage Paired Associate Learning Mediation Paradigm 7 (Response Equivalence)	E 1. Learn or culturally acquire: B-A 2. Learn or culturally acquire: B-C 3. Test: A-C	Kjeldergaard and Horton (1960) Cramer and Cofer (1960)	B-A learned or given in half of test list's A-C pairs. B-A not learned or given in half of test list's A-C pairs. Each S own control.
		C 1. Learn or culturally acquire: B-C 2. Test: A-C		
	Jenkins (1959, 1963) Three-State Mediation Paradigm 8 (Response Equivalence)	E 1. Learn or culturally acquire: B-C 2. Learn or culturally acquire: B-A 3. Test: A-C	Kjeldergaard and Horton (1960) Cramer and Cofer (1960)	B-C learned or given in half of test list's A-C pairs. B-C not learned or given in half of test list's A-C pairs. Each S own control.
		C 1. Learn or culturally acquire: B-A 2. Test: A-C		

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Condition
Successive Practice	Jenkins (1963) Four-Stage Paired Associate Learning Mediation Paradigm 1 (Chain Mediated Stimulus Equivalence)	E 1. Learn or culturally acquire: A-B 2. Learn or culturally acquire: B-C 3. Learn or culturally acquire: A-D 4. Test: C-D C Not stated but see conditions column.	Jenkins, 1963	Not stated, but control believed to consist in not learning or acquiring A-B.
	Jenkins (1963) Four-stage Mediation Paradigm 2 (Chain mediated stimulus equivalence)	E 1. Learn or culturally acquire: B-C 2. Learn or culturally acquire: A-B 3. Learn or culturally acquire: A-D 4. Test: C-D C Not stated but see Conditions column.	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring B-C.

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins (1963) Four-stage Paired Associate Learning Mediation Paradigm 3 (Reverse chain mediated stimulus equivalence)	E 1. Learn or culturally acquire: B-A 2. Learn or culturally acquire: C-B 3. Learn of culturally acquire: A-D 4. Test: C-D C Not stated but see conditions column.	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring B-A.
	Jenkins (1963) Four-Stage Mediation Paradigm 4 (Reverse chain mediated stimulus equivalence)	E 1. Learn or culturally acquire: C-B 2. Learn or culturally acquire: B-A 3. Learn or culturally acquire: A-D 4. Test: C-D C Not stated but see conditions column.	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring C-B.

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins,(1963) Four-stage Paired Associate Learning Mediation Paradigm 5 ("pure" stimulus equivalence)	E	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring A-B.
		1. Learn or culturally acquire: A-B	Shipley, 1935	
		2. Learn of culturally acquire: C-B		
		.3. Learn or culturally acquire: A-D		
		4. Test: C-D		
		C		
		Not stated but see conditions column.		
	Jenkins (1963) Four-Stage Mediation Paradigm 6 ("pure" stimulus equivalence)	E	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring C-B.
		1. Learn or culturally acquire: C-B	Shipley, 1935	
		2. Learn or culturally acquire: A-B		
		3. Learn of culturally acquire: A-D		
		4. Test: C-D		
		C		
		Not stated but see conditions column.		

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins (1963) Four-stage Paired Associate Learning Mediation Paradigm 7 (equivalent response to equivalent stimuli transfer)	E 1. Learn or culturally acquire: B-A 2. Learn or culturally acquire: B-C 3. Learn or culturally acquire: A-D 4. Test: C-D C Not stated but see conditions column.	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring B-A.
	Jenkins (1963) Four-stage Mediation Paradigm 8 (equivalent response to equivalent stimuli transfer)	E 1. Learn or culturally acquire: B-C 2. Learn or culturally acquire: B-A 3. Learn or culturally acquire: A-D 4. Test: C-D C Not stated but see conditions column.	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring B-C.

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins (1963) Four-stage Paired Associate Learning Mediation Paradigm 9 (Chain mediated response equivalence)	E	Jenkins, 1963	Not stated, but control blieved to consist in not learning or acquiring A-B.
		1. Learn or culturally acquire: A-B	Russell and Storms, 1955	
		2. Learn or culturally acquire: B-C	Cofer and Yarczower, 1957	
		3. Learn or culturally acquire: D-A	Schuly and McGehee, 1960	
		$. Test: D-C		
		C		
		Not stated but see conditions column.		
	Jenkins (1963) Four-stage Mediation Paradigm 10 (chain mediated response equivalence)	E	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring B-C.
		1. Learn or culturally acquire: B-C	Russell and Storms, 1955	
		2. Learn or culturally acquire: A-B	Cofer and Yarczower, 1957	
		3. Learn or culturally acquire: D-A	Schuly and McGehee, 1960	
		4. Test: D-C		
		C		
		Not stated but see conditions column.		

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins (1963) Four-stage Paired Associate Learning Mediation Paradigm 11 (reverse chain mediated response equivalence)	E 1. Learn or culturally acquire: B-A 2. Learn or culturally acquire: C-B 3. Learn or culturally acquire: D-A 4. Test: D-C C Not stated but see conditions column.	Jenkins, 1963	Not stated, but control believed to consist in not learning or acquiring B-A.
	Jenkins (1963) Four-stage Mediation Paradigm 12 (reverse chain mediated response equivalence)	E 1. Learn or culturally acquire: C-B 2. Learn or culturally acquire: B-A 3. Learn or culturally acquire: D-A 4. Test: D-C C Not stated but see conditions column.	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring C-B.

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins (1963) Four-Stage Paired Associate Learning Mediation Paradigm 13 (equivalent stimuli to equivalent response transfer)	E 1. Learn or culturally acquire: A-B 2. Learn or culturally acquire: C-B 3. Learn or culturally acquire: D-A 4. Test: D-C C Not stated but see conditions column.	Jenkins, 1963	Not stated but control believed to consist in not learningor acquiring A-B.
	Jenkins (1963) Four-stage Paradigm 14 (equivalent stimuli to equivalent response transfer)	E. 1. Learn or culturally acquire: C-B 2. Learn or culturally acquire: A-B 3. Learn or culturally acquire: D-A 4. Test: D-C C Not stated but see conditions column.	Jenkins, 1963	Not stated but control believed to consist in not learning or acquiring C-B.

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Jenkins (1963) Four-stage Paired Associate Learning Mediation Paradigm 15 ("Pure" Response Equivalence)	E 1. Learn or culturally acquire: B-A 2. Learn or culturally acquire: B-C 3. Learn or culturally acquire: D-A 4. Test: D-C C Not stated.	Jenkins (1963)	Not stated but control believed to consist in not learning or acquiring B-A.
	Jenkins (1963) Four-stage Mediation Paradigm ("Pure" Response Equivalence)	E 1. Learn or culturally acquire: B-C 2. Learn or culturally acquire: B-A 3. Learn or culturally acquire: D-A 4. Learn or culturally acquire: D-C C Not stated.	Jenkins (1963)	Not stated but control believed to consist in not learning or acquiring B-C.

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Conditions
Successive Practice	Stolurow and Swenson (1952) Mediated Serial Learning Transfer Paradigm	E 1. Test A-B word associations from 2. Learn serial list of A stimulus words 3. Learn serial list of positionally opposed B responses	Stolurow and Swenson (1952)	1. Free association test given to S's. 2. Fifteen word-pairs selected. 3. Pairs divided to form lists A and B. 4. Control list D equated with list A. 5. Control list C equated with list B.
		C-1 1. Learn serial list A, then serial list B		
		C-2 1. Learn serial list D, then serial list B		

Table 1 (continued)

Type	Design	Group	Ref. Exper.	Condtions
Successive Practice	Brehman (1966) Mediated Serial Learning Paradigm (Unidirectional or Bi-directional Associations)	E-1 1. Learn serial list A_1 (or A_2) 2. Learn serial list B_1 (or B_2) respectively	Brehman (1966)	E learns one of two A lists containing uni-directional or bi-directiona stimulus word elements, then learns a B list containing postionally opposed word association responses of A list elements. (Mediated facilitation)
		E-2 1. Learn serial list A_1 (or A_2) 2. Learn serial list B_1 (or B_2) respectively		E learns under identical conditions but lists A_1 and A_2 have been scrambled to destroy positional opposition of associated elements in two lists learned. (Mediated interference)
		C-1 1. Learn serial list A_2 (or A_1) 2. Learn serial list B_1 (or B_2)		C learns serial list A that does not have its strong associations in the B list to be learned. (Lists A_1 and A_2 equated as to difficulty)
		C-2 1. Learn serial list C 2. Learn serial list B_1 (or B_2)		C learns serial list C that is equated in difficulty with lists A_1 and A_2, but is incapable of arousing any strong associations found in the B list or elsewhere.

Table 2

Summary of Transfer Design Characteristics

Conditions		Design (Table 1)							
No.	Description	A	B	C	D	E	F	G	H
1.	T1 equated to T2 by previous standardization; i.e., due to equality of tasks first trial of T1 is equivalent to a fore-test in T2. Equated tasks are usually similar; e.g., two mazes.		X	X	X				
2.	Time interval or interpolated activity between T1 and T2.				X				
3.	T1' non-specific preliminary activity or similar to T1 but irrelevant to T2.	X				X			
4.	Groups are pooled first for primary learning and then for secondary learning.						X		
5.	T1 and T1' are similar.								X
6.	T2 and T2' are similar.							X	X
7.	Control Groups	X				X		X	X
8.	Fore-test in T2	X							
	Woodworth Plan	1	2	3		4	5		
	Murdock Design								

CHAPTER III

OBJECTIVE 2: SOME PRINCIPLES OF TRANSFER

The following is a compilation of principles of transfer derived from a selected set of references. Quotation marks were not used because the summary statement of writers in the field have been edited, and in many cases either rewritten or written de novo.

The statements, while in the form of principles, are in reality hypotheses. In most cases they reflect the predominant trend, in terms of findings from experimentation. The number of principles, as well as the number of related studies, do not represent an exhaustive list. However, they are more extensive than any other available source. They represent one phase of words in psychology that should be available to the educator. The purpose of this chapter delineates the major categories of findings in the area of transfer of training, and under each summarizes the principles which give them substance. Doing this hopefully will serve to stimulate the badly needed research as well as the application of principles to practice.

The principles are grouped under fifteen major categories. No attempt was made to stay with areas traditionally accorded as transfer of training. Instead of approaching the problem historically, it was approached logically. The logic is simply that of sequential analysis. The basic assumption is that the learner does not exist in a psychological vacuum before he learns a new task or during the interval between learning one task and recalling it. While activities may not be specified or be specifiable, they exist and the question that arises is one of the relationships between successive experiences that determine the nature and amount of transfer effect produced.

A taxonomic approach was taken to develop the main framework of the chapter. It takes an operational approach to the problem of organizing findings from research. This is done in the hope that it would be of maximum aid to the educator who may want to apply the information in making training educational, or curricular decisions.

Each statement of a principle is followed by two listings of references. The first list of references is followed by a page number, or occasionally by no information. When there is a reference to secondary sources, it is one known to discuss the principle in question, or part of it. The second list references follow the first immediately. It is a list of studies relating to the principle or phenomenon; each is followed by a symbol or shorthand notation which represents the class or category into which they fall, i.e.,

Symbol	Class
+	Principle is supported by study
-	Principle is contradicted by study
O	Inconclusive results by study
M	Principle is modified by study
S	Study relates to principle

Bibliographies:

There are two bibliographies. The major bibliography consists of approximately 1700 titles. The supplementary bibliography consists of approximately 100 titles. Each of these is separately; alphabetized. References cited under principles may be found in either bibliography. Time did not permit their intergration. Supplementary bubliography is attached at the end of this section.

The reference code of Section II--the bibliography--is used in an abbreviated form in this chapter on principles. That part of the code used here contains only the alphabetic designation (part C of the total code), and the TRL serial number (part D of the total code).

TABLE 3

MAJOR HEADINGS FOR THE CLASSIFICATION OF PRINCIPLES AND THEIR CODES

CODE	MAJOR HEADINGS
1.0	Minimal stimulus change without required response change--single cue
2.0	Minimal stimulus change without required response change--two or more cues
3.0	Vanishing and fading - Removal of elicitor
4.0	Extinction - Reinforcement stimulus change--Removal
5.0	Minimal response change without required stimulus change
6.0	Moderate response change without required stimulus change
7.0	Stimulus and response variation
8.0	Discrimination
10.0	Interpolated Activity
11.0	Practice Effects
12.0	Task Characteristics
13.0	Learner Factors
14.0	Warm-up
15.0	Learning to learn

Single Category of Change Between Tasks

1.0 Minimal Stimulus Change Without Required Response Change--Single Cue.

1.1 Associative Shifting: A bond already formed between a situation and a response may be shifted to a part of the situation or even to a new part inserted in the situation.

S-159 Stolurow (1953) p. 3.

Also see: H-043 Hilgard (1948) p. 22; T-014 Thorndike (1913).

1.2 Law of Assimilation: A bond existing between a situation and a response will be activated by similar situations with a probability dependent on the degree of similarity.

S-159 Stolurow (1953) p. 3.

Also see: S-087 Stevens (1951) p. 664.

1.3 Stimulus Generalization: The probability that a new stimulus will be followed by a previously-learned response is an increasing function of the similarity of the new stimulus to which the learned response was conditioned.

H-043 Hilgard (1948) p. 56.

Also see: H-150 Hull (1950); K-032 Kimble (1961) p. 87; M-036 McGeoch and Irion (1952) p. 68; O-008 Osgood (1953) p. 525.

B-217	Bass (1958)+
B-017	Bass and Hull (1934)+
B-211	Brown, Bilodeau and Baron (1951)+
B-212	Brown, Clark and Stein (1958)+
G-051	Grant and Schiller (1953)+
H-063	Hovland (1937)+
H-064	Hovland (1937)+
H-149	Humphreys (1939)+
L-094	Littman (1949)+
M-067	Miller and Dollard (1941)+
N-036	Noble (1950)+
P-060	Philip (1947)+
W-088	Watson & Rayner (1920)+

1.3.01 Generalization Gradient: A decrease in response strength will occur in a regular fashion with increasing differences between test and training stimuli.

K-032 Kimble (1961) p. 331.

Also see: G-070 Guttman and Kalish (1956).

1.3.02 Generalization Decrement: The conditioned response is, to some degree, controlled by stimuli provided by the mere fact of being in the experimental situation and by traces of the rewards and the responses which occurred on previous trials. The changing of any of these stimuli leads to a loss of response strength.

K-032 Kimble (1961) p. 325.
J-148 Hull (1949) C
R-098 Rubin (1953)+

1. 3. 03 Effect of Amount of Training on Generalization: Generalization increases with training in the initial stages of conditioning but becomes restricted with further training.

K-032 Kimble (1961) p. 337.

1. 3. 04 Effect of Continued Reinforcement on Generalization: With continued reinforcement, the range of stimulus generalization initially increases.

K-032 Kimble (1961 p. 335.
Also see: B-216 Beritov, p. 123.

M-160 Margolius (1955)+
H-066 Hovland (1937)+

1. 3. 05 Cross-Modal Generalization: A response conditioned to a particular stimulus is elicited by other stimuli, even if these stimuli are in another modality.

K-032 Kimble (1961) p. 215.

1. 3. 05. 01 Pseudo-Conditioning: A response is strengthed to a previously neutral stimulus through the repeated elicitation of the response by another stimulus without a preceeding paired presentation of the two stimuli.

K-032 Kimble (1961) p. 482.

Also see: H-067 Hovland, p. 618; G-127 Grether (1938).

D-065 Dugort and Kimble (1958)+

G-123 Grant (1943)+

G-124 Grant (1943)+

H-144 Harris (1941)+

K-082 Kimble and Dufort (1956)+

K-083 Kimble, Mann and Dufort (1955)+

1. 3. 05. 02 Sensory Preconditioning: After a number of paired presentations of two stimuli (e. g., a light and a buzzer) and the subsequent conditioning of the subject to one of these stimuli (CS), the other stimulus of the pair will, without previous exposure in the conditioning situation, also act as a CS and elicit the CR.

H-143 Hall (1966) p. 524. K-032 Kimble (1961) p. 215.

B-210 Brogden (1942)0

B-218 Brogden (1947)+

C-078 Chernikoff and Brogden (1949)+

C-032 Coppock (1958)+

K-081 Karn (1947)+

S-165 Seidel (1958)+

S-170 Silver and Meyer (1954)M

W-033 Wickens and Briggs (1951)M

1. 3. 05. 03 Redintegration: The arousal of a response by a fraction of the stimuli whose combination originally aroused it.

K-032 Kimble (1961) p. 482.

Also see: H-067 Hovland, p. 332. E-044 Ellson (1941).

1. 3. 06 Motivational Stimulus Gradient -- Occurrence of an Instrumental Response: An increase in the probability of a response (required in an instrumental learning situation) is more likely if the response previously was associated with cues like those in the new situation, and if it also is already associated with the existing motivational stimuli of the learner.

0-008 Osgood (1953).

1. 3. 07 Effect of Motivation on Generalization: Increased drive broadens the generalization gradient.

K-032 Kimble (1961) p. 340.

B-208 Bersh, Nottermann and Schoenfeld (1956)+

1.3.08 Effect of Extinction on Generalization: The generalization function steepens during extinction.

K-032 Kimble (1961) p. 338.

B-078 Brown (1942)+

H-066 Hovland (1937)+

1.3.09 Effect of Reinforcement Schedule on Generalization: The gradient of generalization following intermittent reinforcement is flatter than that following continuous reinforcement.

K-032 Kimble (1961) p. 340.

H-082 Humphreys (1939c)+

1.3.10 Effect of Discrimination Training on Generalization: A steeper generalization gradient results from training in which discrimination is required than from training in which no discrimination is required.

K-032 Kimble (1961) p. 359.

1.3.11 Effect of Stimulus Intensity on Generalization: Stimuli, the intensities of which are lower than that of the CS, will lead to lessened response strength for two reasons: (a) generalization decrement, and (b) the direct weakening effect of the lower intensity. Stimuli, the intensities of which are increasingly higher than the CS, will lead to stronger responses which are less strong than they might be because generalization decrement tends to weaken the response.

K-032 Kimble (1961) p. 342.

G-051 Grant and Schiller (1953)M

H-152 Hartman and Fitts (1955)+

1.3.12 Effect of Stimulus Frequency -- Target Frequency: Changes in target frequency lead to poorer performance.

H-151 Hartman (1957)+

H-152 Hartman and Fitts (1955)+

Octave Effect: After a conditioning procedure to a specific frequency, subjects gave a stronger response to a frequency one octave below the UCS than to a frequency closer to the UCS.

H-143 Hall (1966) p. 393.

Also see: H-063 Hovland (1937); H-082 Humphreys (1939).

1.3.13 Effect of Stimulus Complexity on Generalization: The extent of generalization appears to increase for a much longer period with complex patterns of stimuli than with a set of single stimulus.

H-067 Hovland, p. 617.

R-005 Razran (1940)+

1.3.14 Effect of Type of Pretraining on Generalization: The slope of the generalization gradient associated with each stimulus differs as a function of the response terms employed during pretraining; steeper slopes are associated with pretraining with the more meaningful response terms.

A-074 Arnoult (1956).

E-045 Ellis and Feuge (1966)-

1.3.15 Higher-order conditioned responses: A conditioned response based upon another conditioned response. A first order response is reinforced by an unconditioned stimulus, a second-order response by a first-order conditioned stimulus, etc., to produce a higher order condtioned response.

F-063 Finch & Culler (1934).

2.0 Minimal Stimulus Change Without Required Response Change -- Two or More Cues.

2.1 Paired Associates and Stimulus Term Similarity: When a task requires the learner to make the same response to new but similar stimuli, the amount of positive transfer increases with increasing stimulus similarity.

E-013 Ellis (1965) p. 73.

Also see: O-008 Osgood (1953) p. 529.

B-089 Bruce (1933)+
D-002 Dallett (1962)0
H-006 Hamilton (1943)+
J-045 Jung (1962)0
P-031 Postman (1962)0
W-062 Wylle (1919)C
Y-007 Yum (1931)+

2.2 Serial Tasks -- Stimulus: Variation in target stimulus (e.g., direct to mirror vision) results in positive transfer.

L-095 Lewis (1953)+
Fitts, Marlowe & Noble (1953)+

2.3 Familiarization: Pre-task familiarization with task stimuli facilitates tachistoscopic recognition of specific stimuli but does not facilitate recognition of their homonyms.

N-003 Neisser (1954).

3.0 Vanishing and Fading - Removal of Elicitor

3.1 Vanishing: A method of removing the auxiliary stimulus by literally vanishing the prompt, part by part.

3.2.1 Fading: A technique of prompt removal in which the prompting stimulus is actually faded in intensity, in saturation, or in some other physical quality while all other parts of the prompt remain the same.

3.2.2 Prompt distortion: A technique of prompt removal, for example, one in which a picture of an object is gradually distorted into the written letters that spell the word.

T-049 Taber & Glaser (1962).

3.3.1 Single Elicitor (See Extinction, 4.0).

3.3.2 Multiple Elicitor

3.3.3 Errorless Discrimination Training: Discrimination learning can occur without the appearance of errors.

T-053 Terrace (1963)+

H-167 Hively (1962) (1965)+
H-168 Hively (1962) (1965)+
M-177 Moore & Goldiamond (1964)+

H-169 Holland & Mathews (1963)+

3.3.4 Instruction: An effect of instruction is to arouse or produce a set which influences behavior in the direction intended -- that is, directs it.

M-036 McGeoch and Irion (1952) p. 201.

Also see: C-006 Carmichael, Hogan and Walter (1932); L-031 Lester (1932); and M-064 Miller and Cole (1936).

3.3.4.01 Effect of Instructions on How to Memorize: Experiments showed that in a case in which one kind of training (unidirected drill) was used there were amounts of transfer of training which were sometimes positive and sometimes negative, but always small. Another kind of training with the same drill material may result in transfer effects which are uniformly large and positive.

H-067 Hovland (1951)+ J-022 Judd (1908)+

W-054 Woodrow (1927)+

3.3.4.02 Effects of Instruction on Recall: Instructing subjects to recall and resist the effects of interpolated material aids them in recall.

See: M-036 McGeoch and Irion (1952); L-031 Lester (1932).

3.3.4.03 Effect of Instruction on Conditioning: Conditioning is better in subjects who have no knowledge of conditioning than it is in subjects who understand the process.

K-032 Kimble (1961) p. 104.

M-162 Miller (1939)S

R-092 Razran (1955)+

W-092 Wittrock & Twelker (in press).

Also see: H-067 Hovland (1951) p. 630.

P-032 Postman & Senders (1946)+

W-091 Wittrock (1963+

3.3.4.04 Inhibitory instructions do not reduce the level of conditioning.

K-032 Kimble (1961) p. 105.

N-037 Norris and Grant (1948) -

3.3.4.05 Effect of Instruction in Relevant Principles: Transfer is facilitated when the initial learning can be formulated in terms of general principles applicable to new learning.

H-067 Hovland (1951) p. 661.

Also see: M-036 McGeoch & Irion (1952) p. 328.

C-036 Coxe (1924)+

F-053 Forgus & Schwartz (1957)+

H-031 Hendrickson & Schroeder (1941)+

H-045 Hilgard, Irvine & Whipple (1953)+

J-022 Judd (1908)+

K-004 Katona (1940)+

W-054 Woodrow (1927)+

3.3.4.06 Effect of Broad Instruction as opposed to Narrow or Specific Instruction: Verbal stimuli, such as rules or concept labels, which directly relate to a class of stimuli rather than to specific instances of that class, produce transfer to other instances of the same class.

W-092 Wittrock & Twelker (in press).

Also see: H-067 Hovland (1951) p. 630.

P-032 Postman & Senders (1946)+

W-091 Wittrock (1963)+

3.3.4.06 Effect of Instruction on Concept Learning or Identification: Instruction relevant to the task to be performed by the subject will facilitate faster acquisition and identification of concepts than irrelevant or no instruction.

R-040 Archer, Bourne & Brown (1955) 0

U-011 Underwood & Richardson (1956)+

3.3.4.07 Effect of Instruction on Problem Solving: The subject's awareness of the givens of a problem is positively related to his ability to solve that problem.

M-018 Marks (1951)

R-010 Reid (1951)+

3. 3. 4. 08 Effect of Instruction on Abstract Problem Solution: Instruction in analysis, abstraction, and generalization produces a distinct positive transfer to problems requiring reasoning and understanding.

M-036 McGeoch & Irion (1952) p. 331-332.

B-012 Barlow (1937)+

3. 3. 4. 09 Effect of Instruction on Part-Whole Task Performance: Variations in knowledge of results about component performance may effect transfer from part to whole performance.

B-170 Bilodeau (1955)+

3. 3. 4. 10 Effect of Instruction and No Instruction: Performance is substantially improved when the subject is aware of the principles involved in the task as opposed to not being so informed.

P-062 Postman & Jarrett (1952).

T-051 Thorndike & Rock (1934).

4.0 Extinction -- Reinforcement Stimulus Change--Removal: When the reinforcing stimulus is removed, the behavioral process that is developed is called extinction. (a) The term refers to the apparent elimination of the overt response previously known to be highly probable in the presence of a specific stimulus or class of stimuli.

(b) Extinction: specific procedure of presenting the conditioned stimulus unaccompanied by the usual reinforcement.

K-032 Kimble (1961) p. 479.

4.01 Effect of Number of CRs on Extinction: The number of CRs in the initial trials is the important determinant of resistance to extinction.

K-082 Kimble & DuFort (1956).

4.02 Effect of degree of Task Training on Extinction: The more highly trained the response the less resistance to extinction.

C-062 Capaldi (1957).

4.03 Cumulative Extinction: When a series of successive extinction sessions is applied, with rest interpolated, it becomes progressively easier to obtain any given extinction criterion.

O-008 Osgood (1953) p. 337.

4.04 Generalization of Extinction: Stimulus generalization, as a phenomenon, applies not only to the effects of training, but also to the effects of extinction.

M-036 McGeoch and Irion (1952) p. 69.

H-064 Hovland (1937)+

H-063 Hovland (1937)+

K-084 Kling (1952)+

The more similar the two original stimuli, the more generalization of extinction interferes with responses.

K-032 Kimble (1961) p. 334.

4.05 Form of Extinction Curve: Extinction is typically a negatively-accelerated function of the number of unreinforced repetitions of the stimulus.

O-008 Osgood (1953) p. 337.

Also see: R-014 Reynolds (1945).

4.06 Disinhibition: Extraneous (novel) stimuli introduced during extinction will temporarily lower the tendency for correct responding.

M-036 McGeoch & Irion (1952) p. 67.

Also see: K-032 Deese (1958) p. 52; O-008 Kimble (1961) p. 478; D-014 Osgood (1953) p. 307.

4.07 Counter Conditioning: Extinction under circumstances in which the response decrement is hastened by the reinforcement of a response which displaces the original conditioned response.

K-032 Kimble (1961) p. 478.

C-021 Cohen, et al (1954)+

4.08 Spontaneous Extinction: Extinction can occur without any non-reinforced trials at all.

K-032 Kimble (1961) p. 307.

Also see: M-169 Moyer (1958)

4.09 Spontaneous Recovery: After extinction has been accomplished (to some arbitrary criterion), a period of rest (usually removal from the original situation) is followed by reappearance of the same response to the stimulus.

O-008 Osgood (1953) p. 337.

Also see: H-063 Hovland (1937); K-032 Kimble (1961) p. 284; M-036 McGeoch and Irion (1952) p. 67.

4.10 Amount of Spontaneous Recovery: Typically, the course of spontaneous recovery through time is accelerated negatively; recovery occurs rapidly at first and then tapers off as rest continues.

D-014 Deese (1958) p. 51.

Also see: O-008 Osgood (1953) p. 337; E-021 Ellson (1938).

B-219 Bilodeau (1952) +

4.11 Effect of Reinforcement Schedule on Resistance to Extinction: If all other things are equal, resistance to extinction after partial reinforcement is greater than that after continuous reinforcement when behavior strength is measured in terms of single responses.

J-017 Jenkins and Stanley (1950).

Also see: K-032 Kimble (1961) p. 318.

D-055 Denny, Wells & Mattsch (1957) +
E-042 Essman (1956) +
F-044 Fattu & Mech (1955) +
F-045 Fattu, Mech and Auble (1955) +
G-107 Grant, Hake and Hornseth (1951) +
H-115 Hake and Grant (1951) M
H-116 Hake, Grant and Hornseth (1951) M

H-134 Hirsch (1957) -

H-139 Hubbard (1951) M

J-017 Jenkins and Stanley (1950) C

K-065 Kanfer (1954) -

L-072 Lewis and Duncan (1956) +

L-073 Lewis and Duncan (1956) -

L-074 Lewis and Duncan (1957) +

L-075 Likely (1952) S

L-081 Logen, Beier and Kincaid (1956) +

M-134 Mech (1953) +

M-144 Myers (1957) S

P-044 Peterson (1956) +

R-092 Razran (1955) +

R-098 Rubin (1953) -

S-130 Sato (1956) +

W-081 Wickens and Snide (1955) +

4.12 Effect of Motivational Variables on Extinction: Increasing the intensity of a need typically results in greater resistance to extinction if such increased intensity is provided during the extinction trials.

H-143 Hall (1966) p. 263.

Also see: M-036 McGeoch & Irion (1952) p. 208.

4.13 Effect of Number of Reinforcements: Some investigators find number of reinforcements positively related to resistance to extinction, some find a negative relationship.

H-143 Hall (1966) p. 263.

4.14 Effect of Amount of Regard on Extinction: Resistance to extinction is an increasing function of the amount of reward obtained during the acquisition trials.

H-143 Hall (1966) p. 263.

4.15 Effect of the Extinction Trial Schedule on Extinction: Massing trials during extinction has the effect of decreasing resistance to extinction or decreasing the tendency to respond on any given trial during extinction.

D-014 Deese (1958).
G-001 Gagne (1951).
P-027 Porter (1939).
R-014 Reynolds (1945).
R-029 Rohrer (1947).
T-004 Teichner (1952).

4.16 Effect of Rapid Stimuli Presentation on Extinction: When stimuli to which a response (GSR) was conditioned were presented too rapidly for accurate recognition, the response was very resistant to extinction.

L-084 Lowenfeld, Rubenfeld and Guthrie (1956).

4.17 Effect of Extinction-Point-Approaching-Goal on Extinction: There is increased resistance to experimental extinction as the extinction point approaches the goal.

L-060 Lambert, Lambert and Watson (1953).

4.18 Effect of Shock on Extinction: In extinction, when shock may serve as either a cue or agent of secondary reinforcement, extinction tends to be significantly delayed over non-shock extinction conditions.

F-055 Freeburne and Schneider (1955).

4.19 Effect of Task Effortfulness on Extinction: Increased effortfulness will result in quicker extinction of the response in question.

K-032 Kimble (1961) p. 285.

M-164 Mowrer and Jones (1943) +

S-066 Solomon (1948) +

4.20 Extinction as Representing the Acquisition of an Antagonistic Response:

See: B-186 Briggs (1954). C-021 Cohen, et al (1954).

5.0 Minimal Response Change Without Required Stimulus Change:

5.1 **Response Generalization -- Single Response:** Following the conditioning of one response, other responses may be elicited by the same conditioned stimulus although there has been no specific training to establish a relationship between this stimulus and these responses.

K-32 Kimble (1961) p. 483.

Also see: A-018 Arnold (1945); B-022 Bekhterev (1932); K-007 Keller & Schoenfeld (1950); K-015 Kellogg (1939); M-036 McGeoch & Irion (1952) p. 326; R-024 Robinson (1932); W-030 Wickens (1943).

5.1.01 **Reinforcement and Response Generalization Gradient:** All responses occurring near in time to the point of reinforcement are strengthened, but to a degree varying with the temporal interval.

O-008 Osgood (1953) p. 308

Also see: S-171 Saltzman (1951); S-172 Saltzman et al (1955).

5.1.02 Effect of Passage of Time on Response Generalization: Generalized responses increase in strength with time.

B-209 Bindra & Cameron (1953) +

5.1.03 Simultaneous Response and Stimulus Generalization: A conditioned response need not be of stereotyped form nor is the variety in its form (the set of responses) uniquely tied to the original conditioning stimulus.

S-159 Stolurow (1953) p. 446.

W-030 Wickens (1943) +

5.2 Response Generalization -- Two or More Responses:

5.2.1 Paired Associates -- Response Similarity: When a task requires the learner to make a new or different response to the same stimuli, transfer tends to be negative and increases as the responses become less similar.

(a) Under conditions of high response similarity, this condition can produce positive transfer.

(b) Also, it is usually more difficult under this condition to obtain negative transfer in verbal learning than it is in motor skills learning.

E-013 Ellis (1965) p. 73.

Also see: M-103 Muller & Schumann (1894).

With unfamiliar paired-associates materials if the responses are different or similar, the relative number of trials required to learn the second list tends to increase with increased learning of the first list if the stimuli are identical; but the amount of the increase is less when the responses are similar than when they are different.

O-008 Osgood (1953) p. 529.

Also see: E-013 Ellis (1965).

B-089 Bruce (1953) +

B-092 Bugelski (1942) +

B-094 Bugelski & Cadwallader (1956) -

D-002 Dallet (1962) +

J-045 Jung (1952) +

M-074 Morgan & Underwood (1956) +

P-028 Porter & Duncan (1953) 0

S-049 Siipola (1941) +

T-037 Twedt & Underwood (1959) +

U-005 Underwood (1957) +

W-062 Wylie (1919) +

5.2.2 Effect of Practice on Learning New Responses to Old Stimuli: With meaningful paired associates material the number of trials required to learn a list of new responses to old stimuli decreases with the number of preceding responses the subject has already learned to those stimuli.

O-008 Osgood (1953) p. 526.

Also see: M-036 McGeoch & Irion (1952) p. 399.

5.3 Regression: When a subject learns two responses to a single stimulus and stress is applied he typically makes the first learned response.

B-220 Barthol & Ku (1959) +

5.4 Position in Habit-Family Hierarchy: The position in the hierarchy, and hence the probability of occurrence of a given response, varies with the degree to which it previously has been reinforced in similar situations.

O-008 Osgood (1953) p. 613.

Also see: B-036 Birch (1945); H-074 Hull (1934).

5.4.1 Habit-Family Hierarchy: A number of habitual alternative behavior sequences which have in common the initial stimulus situation and the final reinforcing state of affairs form a hierarchy and the alternatives have a preferential order which is the hierarchy.

K-032 Kimble (1961) p. 480.

5.4.2 Temporal Effects on Response Hierarchy: The relative strengths of responses within any hierarchy may vary within limits from time to time.

O-008 Osgood (1953) p. 614.

Also see: H-164 Hovland (1938); S-167 Shipley (1939).

6.0 Moderate Response Change Without Required Stimulus Change:

6.1 Shift of Instrumental Response: Instrumental sequences may shift without any new learning whatsoever.

O-008 Osgood (1953) p. 409.

Also see: W-028 Wickens (1938).

6.2 Bilateral Transfer: Positive transfer from a member on one side of the body to its opposite occurs in varying amounts over a wide range of activities.

M-036 McGeoch & Irion (1952) p. 312, 325.

Also see: B-056 Bray (1928); L-017 Lashley (1924); W-057 Woodworth (1938).

A-048 Albright, Borrensen & Marx (1956) M

B-058 Briggs & Brogden (1953) -

G-012 Gaydos (1956) +

H-153 Hauty (1953) 0

K-031 Kimble (1952) M

6.3 Predifferentiation Training: Facilitation in learning a new stimulus-response task occurs as a result of some type of preliminary experience or practice with the stimuli themselves.

E-013 Ellis (1965) p. 49.

Also see: G-022 Gibson (1942); M-067 Miller & Dollard (1941).

A-022 Arnoult (1953) 0

B-004 Baker & Wylie (1950) +

B-019 Battig (1956) +

C-001 Campbell & Freemen (1955) 0

C-003 Cantor (1955) +

Cantor & Hottel (1957) +

E-019 Ellis, et al (1962) 0

E-018 Ellis & Muller (1964) +

G-004 Gagne & Baker (1950) +

G-042 Goss (1953) +

G-046 Goss & Greenfeld (1958) +

K-051 Kurtz & Hovland (1953) +

M-027 McAllister (1953) +

N-012 Norcross & Spiker (1957) +

R-026 Robinson (1955) 0

R-030 Rossman & Goss (1951) +

S-062 Smith & Goss (1955) +

S-078 Spiker (1956) +

V-004 Vanderplas, Sanderson & Vanderplas (1964) +

6.3.01 Effect of Stimulus Meaning in Transfer of Predifferentiation Training: Increased meaningfulness of stimuli in predifferentiation training results in increased performance on the new learning task.

E-046 Ellis, Muller & Tosti (1966) +

P-064 Pfafflin (1960) +

V-012 Vanderplas & Garvin (1959) -

7.0.0 Second Language Studies:

A-002	Agard (1958)
A-014	Antioch College (1960)
A-026	Asher (1962)
A-027	Astington (1959)
B-011	Barcus, Hayman and Johnson (1961)
B-037	Birkmaier (1949)
B-038	Birkmaier (1960)
B-041	Blayne (1946)
B-045	Bond (1953)
B-046	Burglum (1958)
B-047	Burglum (1956)
B-055	Braunschausen (1910)
C-012	Carroll (1963)
C-013	Carroll (1960)
C-014	Carton and Carroll (1960)
C-017	Cheydleur and Schenck (1950)
C-034	Coxe (1923)
C-041	Creore and Hanzeli (1960)
C-048	Curran (1961)
D-017	Delatire (1960)
D-040	Dunkel (1948)

F-013	Ferrell (1956-1957)
F-014	Ferster, Sapon (1958)
F-015	Ferster, Sapon (1960)
F-032	Forlano, Hoffman (1937)
F-033	Fotos (1955)
H-004	Hamilton, Haden (1950)
H-007	Hammond (1962)
H-051	Hoge (1939)
H-053	Hovlfeld (1950)
K-001	Kale, Grosslight (1955)
L-030	Lermontoff (1961)
L-048	Ludgate (1923)
M-021	Marty (1962)
M-073	Moraud (1961)
M-078	Morgan, Foltz (1944)
M-093	Mueller (1962)
P-020	Pimsleur (1963)
P-022	Pimsleur, Mace, Keislar (1961)
P-026	Porter (1958)
R-012	Reiff (1961)
R-016	Richards (1945)
R-017	Richards, Ilsley, Gibson (1950)

R-018	Richards, Appel (1955)
S-008	Saltzman (1963)
S-011	Sapon (1952)
S-012	Sapon (1961)
S-015	Saporta (1963)
S-017	Schenck (1952)
S-021	Schmidt (1923)
S-033	Seibert (1930)
S-056	Skinner (1960)
S-101	Sweet (1961)
S-102	Sweet (1962)
T-003	Teaching Machines (1960)
T-032	Toronto Board of Education (1960)
V-001	Valdman (1962)
W-021	Wertheimer, Scherer (1962)

Multiple Category of Change

7.0 Stimulus and Response Variation: With response identity, the absolute amount of transfer is a positively accelerated increasing function of the inter-task stimulus similarity, with increasing departure from response identity (toward response similarity). There is a point at which zero transfer results regardless of variations in stimulus similarity; with further changes in response (neutral, opposite and antagonistic) the absolute amount of transfer is a positively accelerated decreasing function of stimulus similarity.

O-008 Osgood (1953) p. 532.

Also see: G-021 Gibson (1941); H-143 Hall (1966) p. 486.

7.0.1 Stimulus and response change: Rotary pursuit: Along the speed dimension, the greater the speed of the task, the poorer the performance.

A-052 Ammons, Ammons & Morgan (1954)+

7.1 Mediation: Transfer can occur as a result of mediation due to the network of associative linkages shared by the tasks.

7.1.1 Mediated Generalization: Stimuli otherwise unlike may provide the basis for generalization through the equivalence of the responses which they evoke.

Also see: 1.3.15 - Higher Order Conditioning

H-047 Hilgard & Marquis (1940) p. 344.

7.1.1.01 Naturally Occurring Association -- Paired Associates: Mediated generalization may occur as a result of associations created by culturally determined everyday experience.

C-020 Cofer, Janis & Rowell (1943)+

F-029 Foley & Cofer (1943)+

F-030 Foley & MacMillan (1943)+

7.1.1.02 Naturally Occurring Association -- Serial Learning: (See 7.1.1.01)

B-223 Brehman (1966)0

S-175 Stolurow & Swenson (1957)+

7.1.1.03 Experimentally Acquired Association -- Motor Response Mediator: Mediated generalization may occur in an experimental situation by establishing arbitrary associations such that a motor response acts as mediator.

J-028 Jeffrey (1953)+

L-089 Lumsdaine (1939)+

S-044 Shipley (1933)+

7.1.1.04 Experimentally Acquired Association -- Perceptual Response Mediator: Mediated generalization may occur in an experimental situation by establishing arbitrary associations such that a perceptual response acts as a mediator.

E-044 Ellson (1941)+ E-051 Ellson (1942)+

G-121 Grice & Davis (1958)+

K-009 Keller (1943)+

7.1.1.05 Experimentally Acquired Association -- Emotional Response Mediator: Mediated generalization may occur in an experimental situation by establishing arbitrary associations such that an emotional response (e.g. anxiety) acts as mediator.

M-065 Miller (1948)+

7.1.1.06 Experimentally Acquired Association -- Verbal Response Mediator: Mediated generalization may occur in an experimental situation by establishing arbitrary associations such that a verbal response acts as mediator.

F-031	Foley & Mathews (1943)+
J-028	Jeffrey (1953)+
M-113	Mednick (1957)+
W-033	Wickens & Briggs (1951)+

7.1.1.07 Sensory Preconditioning: (See 1.3.05.02 - Sensory Preconditioning)

7.1.1.08 Semantic Generalization: Mediated generalization may occur through the existence of semantic relationships between words, pictures, or other objects.

B-128	Branca (1957)0
G-038	Goodwin, Long & Welch (1945)+
L-090	Lacey & Smith (1954)+
L-091	Lacey, Smith & Green (1955)+
M-012	Maltzman & Brooks (1956)M
O-008	Osgood (1953)C
R-004	Razran (1939)M
R-093	Reiss (1946)M

7.1.1.08.1 Free Association Mediator -- Clustering of Recall: Clustering, regrouping of terms, in recall may occur because of semantic generalization.

B-050	Bousfield (1953)+
B-052	Bousfield & Cohen (1955)+
B-204	Bousfield & Sedgewick (1944)+
B-051	Bousfield, Whitmarsh & Danick (1958)+
J-012	Jenkins & Cofer (1957)+
J-011	Jenkins & Russell (1952)+
J-010	Jenkins, Mink & Russell (1958)+

7.1.2 Habit-Family Hierarchies: Some stimulus patterns (e. g., words) become associated with systems of mediating reactions which may be associated with skill sequences (e. g., anxiety mediating processes may be associated with avoidance behavior). These systems are called habit-family hierarchies.

O-008	Osgood (1953) p. 401. (See: 5.4; 5.4.1; 5.4.2).
B-203	Bousfield, Whitmarsh & Danick (1958)+
G-007	Gagne & Paradise (1961)+
J-012	Jenkins & Cofer (1957)+
M-154	Merrill (1964)+
W-027	Whitmarsh & Bousfield (1961)+

7.1.2.1 Divergent Hierarchy: A divergent hierarchy is one in which a given pattern of stimulation is variably associated with a number of alternative reactions.

O-008 Osgood (1953) p. 402.

7.1.2.2 Convergent Hierarchy: A convergent hierarchy is one in which each one of a set of distinctive patterns is associated with a simple reaction.

O-008 Osgood (1953) p. 402.

7.1.3 Mediation in Serial List Recall: The probability of extra-list intrusions during serial list recall is proportional to the mean association strength of the intruding word with regard to the words in the serial list and inversely related to the degree of inter-item association strength between the words in the serial list being recalled.

D-015 Deese (1959).

D-016 Deese (1959).

7.1.4 Mediation in Paired-Associates Learning: Positive mediated transfer has been demonstrated to occur by using specially constructed paired-associate paradigms [e. g., A-B, B-C, A-C or A-B, (B--C--D) A-D] involving at least three stages.

B-010 Barclay (1963)0

B-013 Barnes (1959)+

B-201 Bastian (1956)+

B-137 Bugelski & Scharlock (1952)+

C-086 Carlin (1958)+

C-040 Crawford & Vanderplas (1959)0

P-001 Palermo (1962)-

R-040 Russell & Storms (1955)+

7.1.4.1 Three-Stage Mediated Facilitation as Influenced By Indirect Formation of Backward & Forward Associations: During paired associate learning involving verbal stimuli and responses backward as well as forward associations are formed which contribute to three-stage mediated facilitation.

C-083 Cofer & Musgrave (1963) p. 217.

C-076 Cramer & Cofer

F-046 Feldman & Underwood (1957)+

J-040 Jantz & Underwood (1958)+

K-080 Kjeldergaard & Horton (1960)+

M-119 Murdock (1956)+

M-158 Murdock (1958)+

R-084 Richardson (1960)+

S-122 Storms (1958)+

7.1.4.2 Four-Stage Mediation: Mediation effects during paired associative learning have not generally been demonstrated at the 4-stage level.

J-029 Jenkins (1963).

7.1.5 Associative Interference of Mediators: When two of the stages in a mediation pardigm begin with the same stimulus, interference occurs and the mediating terms are extinguished prior to mastery of the test list.

B-013 Barnes & Underwood (1959)+

J-041 Jenkins, Foss & Odom (1965)+

F-062 Fitts & Deininger (1954)+

7.1.6 S-R Compatibility: This is a synonym for meaningfulness and belongingness for specifying these conditions in motor learning [Compatibility effects are conceived as arising from an intervening information transformation process.]
S-R compatibility is maximum when the pairings of stimulus and response elements in the formation of an S-R ensemble insure maximum agreement with population stereotypes.

F-062 Fitts & Deininger (1954)+

7.2 Reversal Shift - Extinction of Old S-R: In a reversal shift the positively reinforced S-R becomes negatively reinforced (or unreinforced) and the previously negative S-R becomes positively reinforced.

(Also see: 15.1 Reversal Learning Set)

H-143 Hall (1966) p. 506.

7.2.1 Reversal Shift as Opposed to Non-Reversal Shift: Subjects required to make reversal shifts generally do better than subjects who are required to make a non-reversal shift.

B-111 Buss (1953)+

B-112 Buss (1956)+

H-022 Harrow and Friedman (1958)+

H-061 House and Zeaman (1962)M

K-019 Kendler and D'Amato (1955)+

K-079 Kendler and Kendler (1959)+

T-052 Tighe (1964)+

7.2.2 Repairing of S-Rs in Multiple Pair: Restructuring of the S-R connection so that no new stimuli or responses are introduced but the existing stimuli and responses are re-paired (new S-R connections).

D-035 Duncan (1953).

G-069 Gagne, Baker and Foster (1950).

L-069 Lewis, McAllister and Bechtoldt (1953).

S-171 Stratton (1897).

7.2.2.1 Re-pairing as Opposed to Introduction of New Responses to Old Stimuli: Re-pairing results in negative transfer whereas the pairing of new responses to old stimuli results in no negative transfer.

P-028 Porter and Duncan (1953).

7.2.2.2 Effect of Stress on Re-Pairing: Subjects under stress make more errors after re-pairing than subjects under no stress.

C-054 Castaneda (1956).

P-042 Palermo (1957).

7.3 Proactive Facilitation: In the A-B-C paradigm, proactive facilitation occurs when learning task A aids the subject in performance or retention of task B (subject learns task B faster or more efficiently than A) and learns C more easily than B.

(See 15.0 Learning to Learn).

7.4 Proactive Interference: When a previously established habit has a negative effect upon the acquisition of a new habit proactive interference has occurred.

M-036 McGeoch and Irion (1952) p. 394.

Also see: Melton and Von Lackum (1941).

7.4.1 Effect of Stimulus Similarity on Proactive Interference: Proactive interference increases with increasing stimulus dissimilarity up to the point where stimuli are different. When stimuli are different there is less interference than when the stimuli are similar.

M-036 McGeoch and Irion (1952) p. 396.

Also see: B-092 Bugelski (1942); O-008 Osgood (1953); U-009 Underwood (1944).

Blankenship and Whitely (1941)+

M-051 Melton and Von Lackum (1941)+

7.4.2 Effect of Response Similarity on Proactive Interference: With identical stimuli, increasing amounts of response similarity result in less and less proactive interference.

M-036 McGeoch and Irion (1952) p. 397.

Also see: O-008 Osgood (1953).

M-074 Morgan and Underwood (1950)+

7.4.3 **Effect of Time Interval Between Learning and Relearning on Proactive Interference:** With increasing length of the retention interval proactive interference increases.

Jones (1953)S
K-085 Keppel and Underwood (1962)+
M-041 McGeoch and Underwood (1943)M
M-052 Melton and Von Lackum (1941)M
M-170 Murdock (1961)M
P-062 Peterson and Peterson (1959)O
U-004 Underwood (1949)C
W-093 Wickens, Born and Allen (1963)+

7.4.4 **Effect of Number of Lists Learned on Recall -- Proactive Interference:** Whether serial or paired associates learning, percent recall of each list is a negatively accelerated inverse function of number of previous lists learned.

U-007 Underwood (1957) p. 51.
Also see: M-036 McGeoch and Irion (1952) p. 398.

L-031 Archer (unpublished data)+
B-220 Belmont and Birch (1951)+
C-082 Cheng (1929)+
G-022 Gibson (1942)+
G-108 Greenberg and Underwood (1950)+

H-154 Hovland (1940)+

J-046 Johnson (1939)+

K-086 Krueger (1929)+

Lester (1932)+

U-028 Underwood (1952)+

U-016 Underwood (1953)+

U-017 Underwood (1953)+

U-029 Underwood (1953)+

U-030 Underwood and Richardson (1956)+

W-094 Williams (1950)+

Y-011 Youtz (1941)+

7.4.5 Effect of Number of Conditions Served in by Subjects Prior to Learning Task on Recall -- Proactive Interference: When subjects have learned several lists beforehand, forgetting after relatively short periods of time is greater than it is after twenty-four hours if the subject has served in only one condition.

U-007 Underwood (1957) p. 54.

Y-011 Youtz (1941)+

7.5 Retroactive Neutrality: There is no effect on either the learning of the new or the recall of the earlier learning when the interpolated material involves neutral stimuli.

O-006 Osgood (1959)+

B-094 Bugelski and Cadwallader (1956)+

7.6 Retroactive Facilitation: There may be a facilitating effect of a second task on the performance or retention or a task previously learned.

H-006 Hamilton (1943)

7.6.01 Retroactive Facilitation when Stimuli are Neutral and Responses are Identical: A facilitation effect on learning and retention of task A results after learning an interpolated task B which has both neutral stimuli and identical responses as contrasted with the effect which results when task B has neutral stimuli but similar responses.

B-094 Bugelski and Cadwallader (1956)+

7.6.02 Retroactive Facilitation when Stimuli are Varied and Responses are Functionally Identical: Positive transfer and retroactive facilitation result when stimuli are varied and responses are functionally identical, and it increases as similarity among the stimulus members increases.

O-006 Osgood (1949) p. 134.

B-094 Bugelski and Cadwallader (1956)+

7.7 Retroactive Interference: There may be an interference effect of a second task upon the performance or retention of its predecessor.

M-036 McGeoch and Irion (1952) p. 130.

O-006 Osgood (1949)+

B-094 Bugelski and Cadwallader (1956)+

7.7.01 Effect of Response Similarity on Retroactive Interference: When stimuli are functionally identical and responses are varied negative transfer and retroactive interference are obtained. The magnitude of both first increases and then decreases as similarity between the responses increases. (see 7.7.03; Skaggs-Robinson hypothesis)

B-094 Bugelski and Cadwallader (1956) p. 364.

B-089 Bruce (1933)-

G-021 Gibson (1941)-

P-005 Osgood (1946)-

O-008 Osgood (1953)-

U-002 Underwood (1945)-

7.7.02 Effect of Both Stimulus and Response Variation on Retroactive Interference: When both stimulus and response items are simultaneously varied, negative transfer and retroactive interference increases as stimulus similarity increases.

O-008 Osgood (1953) p. 529.

B-094 Bugelski and Cadwallader (1956) p. 364+

J-047 Johnson (1933)+

M-037 McGeoch and McDonald (1931)+

M-052 Melton and Von Lackum (1941)+

7.7.03 Effect of Degree of Similarity in Content or Material Between Original and Interpolated Activities -- Skaggs-Robinson Hypothesis: As similarity between interpolation and original memorization is reduced from near identity, retention falls away to a minimum and then rises again, but with decreasing similarity it never reaches the level obtaining with maximum similarity. (see 7.7.01)

M-035 McGeoch (1942) p. 461.

H-155 Harden (1929)+

R-023 Robinson (1920)+

K-087 Kennelly (1941)0

R-099 Robinson (1927)+

S-053 Skaggs (1925)+

7.7.04 Effect of Degree of Similarity of Task or Operation Between Original and Interpolated Activities and Retroactive Interference: Interference increases with increasing similarity.

M-035 McGeoch (1942) p. 468.

Gibson and Gibson (1934)+

Water and Pell (1935)+

7.7.05 Effect of Degree of Learning of Original Activity on Retroactive Interference: Interference first increases and then decreases as a function of degree of original task learning.

O-008	Osgood (1953) p. 537.
B-189	Briggs (1957)S
B-089	Bruce (1933)0
G-005	Gagne and Foster (1949)+
G-022	Gibson (1942)+
M-034	McGeoch (1929)0
R-005	Razran (1940)+
S-050	Siipola and Israel (1933)+

7.7.06 Effect of Degree of Learning of Interpolated Activity on Retroactive Interference: Amount of retroactive interference at first increases and then shows a tendency to decrease as degree of interpolated learning is increased.

M-036	McGeoch and Irion (1952) p. 417.
A-016	Archer and Underwood (1951)S
B-189	Briggs (1957)S
L-035	Lewis, Smith and McAllister (1952)S
M-147	McAllister and Lewis (1951)S

M-051 Melton and Irwin (1940)+

O-012 Osgood (1948)-

T-024 Thune and Underwood (1943)-

7.7.07 Effect of Time of Interpolation Between Learning and Recall on Retroactive Interference: Interference is very great when interpolated activity follows learning directly; interference then decreases but it increases again if the interpolated activity is introduced just before the test of retention.

K-077 Kundu (1949).

N-028 Newton and Wickens (1956)M

Newland (1953)S

7.7.08 Effect of Type of Interpolated Activity on Retroactive Interference -- Sleep vs. Waking (Daily Life Activity): Interference is more pronounced under waking conditions than under conditions where sleep is the interpolated activity.

M-036 McGeoch and Irion (1952) p. 421.

J-009 Jenkins and Dallenbach (1924)+

V-006 Van Ormer (1932)+

7.7.09 **Effect of Amount of Original Material on Retroactive Interference:** Small but regular decreases in interference have been found with limited increase in amount of original task material.

M-036 McGeoch and Irion (1952) p. 418.

R-095 Robinson and Darrow (1924)+
R-096 Robinson and Heron (1922)+

7.7.10 **Effect of Amount of Interpolated Material on Retroactive Interference:** At least with verbal materials, it appears that, the greater the amount of interpolated material, the greater the interference.

L-097 Lewis and McAllister (Tech. Rep. SIC 938-1-2)0
R-095 Robinson and Darrow (1924)-
R-096 Robinson and Heron (1922)-
T-038 Twining (1940)+

7.7.11 **Effect of Electric Shock on Retroactive Interference:** Administration of shock for errors in the original learning of a stylus maze markedly reduces retroactive interference, if shock is used. During interpolated learning when the original learning was without shock then interference is reduced.

M-036 McGeoch and Irion (1952) p. 428.

B-106 Bunch and McTeer (1932)+

7.7.12 Effect of Age on Retroactive Interference: An irregular tendency has been found for amount of interference to decrease as CA increases from 8 to 16 years.

L-004 Lahey (1937).

7.7.13 Effect of IQ on Retroactive Interference: The degree of interference appears to be inversely related to IQ.

M-036 McGeoch and Irion (1952) p. 428.

7.7.14 Effect of Set on Retroactive Interference: An apperceptive set congruous with the original material has a greater interference effect than one not congruous with it.

W-095 Whitely (1927)+

P-063 Postman and Postman (1948)+

7.7.15 Retroactive Inhibition and Connected Discourse: When prose or connected discourse is the material to be learned and recalled, retroactive interference effects due to interpolated learning can occur.

S-179 Slamecka (1960).

A-068 Ausubel, Robbins and Blake (1957)0

H-118 Hall (1955)0

Hardman (1954)0

M-171 McGeoch and McKinney (1934)0

7. 8 Association Reversal -- Naturally Acquired: Directional association occurs when the presentation of one item becomes the occasion for choosing or emitting a second item, the second item will also tend to become the occasion for choosing or emitting the first item, but to a lesser degree. (see: 7. 1. 4. 1)

S-174 Stolurow, Detambel and Newmann (1956).

J-040 Jantz and Underwood (1958)+
M-158 Murdock (1958)+

7. 9 Association Reversal -- Experimentally Acquired: When subjects are required to learn associations in what might be generally designated as the A-B direction of association and then in the B-A direction, the task involves association reversal. If learning in each of these orders is considered a separate task, then association reversal is a special case of transfer of training. Association reversal may result in negative transfer.

S-174 Stolurow, Detambel and Newman (1956) p. 1-2.
S-173 Stolurow, Hodgson and Silva (1956) p. 22.

7. 9. 1 Association Reversal -- Conventional Paired-Associates: Conventional paired associate learning involves a one-to-one S-R relationship. Upon reversal the relationship, still one-to-one, is R-S.

7.9.1.1 **Effect of Stimulus-Term Similarity on Association Reversal:** As similarity among the stimulus-terms of S-R pairs is increased, the number of S-terms correctly elicited using the R-terms as a stimulus following S-R learning will decrease.

N-038 Newman and Buckhout (1962) p. 431.

7.9.1.2 **Effect of Response-Term Similarity on Association Reversal:** As similarity among the response-terms of S-R pairs is increased, the number of S-terms correctly elicited using the R-term as a stimulus following S-R learning will decrease.

N-038 Newman and Buckhout (1962) p 431.

7.9.2 **Association Reversal -- Paired Sets of Associates:** The distinction between conventional paired-associates and paired sets of associates is that whereas the former has the one-to-one (S-R) relationship, the latter involves, for example, one-to-many $\left(S \begin{smallmatrix} \nearrow R1 \\ \rightarrow R2 \\ \searrow R3 \end{smallmatrix}\right)$ relationship, many-to-one $\left(\begin{smallmatrix} S1 \searrow \\ S2 \rightarrow \\ S3 \nearrow \end{smallmatrix} R\right)$ relationship and many-to-many $\left(\begin{smallmatrix} S1 & \rightarrow & R1 \\ & \times & \\ S2 & \rightarrow & R2 \end{smallmatrix}\right)$ relationship. Such complex S-R associates involve various degrees of S-R sharing and may affect, differentially, reversal of these associates.

S-174 Stolurow, Detambel and Newman (1956) p. 2.

7.9.2.1 Effect of Amount of Sharing on Association Reversal: As the amount of S-term and R-term sharing increases, the number of trials required to bring the learner to the same level of proficiency in the reverse direction of association increases. As amount of sharing increases transfer changes from positive to negative.

S-174 Stolurow, Detambel and Newman (1956) p. 8.

M-172 Mattson (1961)+

P-063 Postman and Postman (1948)+

7.9.2.2 Effect of Degree of Practice on First Task on Association Reversal: As degree of practice on the first task increases, transfer effects under the reversal condition change from negative to positive.

S-173 Stolurow, Hodgson and Silva (1956) p. 22.

7.9.2.3 Rate of Learning of Types of Paired Sets of Associates Under Association Reversal: The first associations learned were the one-to-one linkages; the next were the linkages involving stimulus sharing (1-2), the third involved response sharing (2-1), and the last were those involving overlapping (2-2).

M-172 Mattson (1961) p. 17.

Discrimination

8.0 Discrimination: While not usually considered as a transfer phenomenon, stimulus discrimination does involve prior learning. The problem in discrimination training is to eliminate undesired responses. It is necessary to give the learner discrimination training because of interference between the responses he has already associated with the different stimuli. For either of two reasons, two or more stimuli may be sufficiently similar to elicit the same or similar response. One reason is stimulus generalization; the other is acquired similarity coming from the deliberate learning of the same response to the set of stimuli.

See: K-032 Kimble (1961) p. 361.

8.0.1 Discrimination Training Through Extinction Procedures: Discrimination may be produced through the weakening of generalized responses by non-reinforcement, while strengthening a response to some particular stimulus by its reinforcement.

K-032 Kimble (1961) p. 362.

8.0.2 Discrimination Training by Method of Successive Presentation of Stimuli: Only one of two stimuli to be discriminated is presented on each trial. Reinforcement follows one stimulus and not the other, with the result that the subject comes to respond to one of the two stimuli and to inhibit response to the other.

Patterning involves the method of successive presentation in which two stimuli, presented together, are reinforced, but either of them presented alone is not.
K-032 Kimble (1961) p. 362.

8.0.3 Discrimination Training by the Method of Simultaneous Presentation of Stimuli: In instrumental learning discriminations are more commonly studied where the positive and negative stimuli are present simultaneously. Under these conditions, the relational characteristics of the stimuli may be easier for subjects to notice than when the stimuli are present separately. Also, under this method, the choice is usually between two reactions rather than between reaction and restraint.

8.1 Discrimination -- Two Stimuli:

8.1.01 Discrimination as Conditioning-Extinction Procedures: Trials with the positive, or reinforced, stimulus are conditioning trials; trials with the negative, or non-reinforced stimulus, are extinction trials.

K-032 Kimble (1961) p. 364.

Also see: S-116 Spence (1936)

S-069 Spence (1937)

S-070 Spence (1937)

H-077 Hull (1939)

H-078 Hull (1943)

H-150 Hull (1950)

H-151 Hull (1952)

E-045 Eimas and Shepp (1964).

8.1.02 Effect of Stimulus Similarity on Discrimination: Psychophysically dissimilar stimuli will be more easily discriminated than psychophysically similar stimuli.

K-032 Kimble (1961) p. 368.

Also see: H-143 Hall (1966) p. 451.

G-130 Gynther (1957)+

8.1.03 Effect of Motivation on Discrimination: Increasing motivation will facilitate the development of a discrimination.

K-032 Kimble (1961) p. 371.

B-224 Buchwald and Yamaguchi (1955)+

E-047 Eisman (1956)+

E-048 Eisman, Asimow and Maltzman (1956)+

8.1.04 Effect of Simultaneous vs. Successive Training on Discrimination: Simultaneous training may or may not result in more efficient discrimination learning. Results have been equivocal, some experiments finding simultaneous discriminations easier to form (e.g., S-176 Spence, 1952; N-031 North and Jeeves, 1956); in others successive discrimination has been found easier (B-223 Bitterman and Wodinsky, 1953; W-097 Weise and Bitterman, 1951). G-131 Grice (1949) found no difference.

B-223 Bitterman and Wodinsky (1953).
G-131 Grice (1949).
K-032 Kimble (1961) p. 375.
N-031 North and Jeevas (1956).
S-176 Spence (1952).
W-097 Weise and Bitterman (1951).

8.1.05 Effect of Practice on Discrimination: There is improvement in the ability of subjects to master discrimination problems with practice at making such discriminations.

(See: 15.1 Learning Sets)

K-032 Kimble (1961) p. 385.

Also see: M-036 McGeoch and Irion (1952).

H-014 Harlow (1949)+

H-161 Harter (1965)M

H-160 House and Zeaman (1959)+

K-053 Kaufman and Peterson (1958)+

8.1.06 Effect of Presentation of Stimuli on Discrimination: The accuracy of discrimination is reduced when the stimuli are presented rapidly and in irregular order.

H-067 Hovland (1951) p. 617.

C-084 Cole, Woodbury and Philled (1942)+

8.1.07 Effect of Amount of Generalization on Discrimination: The ease of obtaining discrimination between two stimulus situations is inversely related to the amount of generalization between them.

O-008 Osgood (1953) p. 357.

8.1.08 Effect of Stimulus Complexity on Discrimination Responses: Reaction time increases as the scale values (degree of complexity) of stimulus complexity increases.

G-085 Gregg (1954)+

8.1.09 Relationship of Training and Test Stimuli in Transfer of Discrimination: Transfer of discrimination training from one task to a second task is positive when the stimuli employed are distinguished by the same property in both tasks (e.g., color)and transfer is negative when the stimuli are distinguished by different properties in the two tasks (e.g., color then form).

K-062 Kurtz (1955)+

Wickens and Eckstrand

8.1.10 Effect of Type of Training on Discrimination Transfer: Subjects who approach a test discrimination through a series of graduated steps perform better than subjects trained on an easy discrimination and are abruptly shifted to the test discrimination.

(See: 3.3.3 - Errorless Discrimination).

B-005 Baker and Osgood (1954)+

8.2 Discrimination -- More Than Two Stimuli.

(See: 9.1.02; 9.1.03; 9.1.05; 9.1.06; 9.1.07).

8.2.01 Transposition: The subject, instead of choosing the originally reinforced stimulus, now selects the new stimulus which bears the same relationship to the originally positive stimulus as the originally positive stimulus did to the negative stimulus. Transfer of this type of discrimination to new pairs of stimuli is called transposition.

K-032 Kimble (1961) p. 379.

Also see: H-143 Hall (1966) p. 453; O-008 Osgood (1953) p. 445.

B-219 Baumeister, Beedle and Hawkins (1964)+

K-049 Kuenne (1946)+

J-020 Jones and Dunn (1932).

J-004 Jackson, et al (1938).

J-003 Jackson and Jerome (1943).

W-023 Wesman and Eisenberg (1941).

8.2.02 Oddity Training: Discrimination training in which three stimuli are presented together, two of which are identical and the third "odd"; the odd stimulus being reinforced.

H-143 Hall (1966) p. 31.

H-152 House (1964).

H-153 House (1964).

8.3 Extinction of Generalized Conditioned Response: Primary stimulus generalized conditioned reaction tendencies are more susceptible to experimental extinction than are reactions actually conditioned to the response; and the wider the generalization, the greater the susceptibility.

S-159 Stolurow (1953) p. 466.

Also see: H-067 Hovland (1951) p. 616.

H-065 Hovland (1937).

H-163 Hull (1947).

8.4 Discrimination Reversal: Discrimination task in which the second discrimination involves reversing the first discrimination.

(See: 7.9 - Reversal Shift).

8.4.01 Effect of Reinforcement Schedule on Discrimination Reversal: Discrimination reversal seems to be more readily accomplished under differential and partial reinforcement than under continuous reinforcement.

B-110 Buss (1952)+

8.4.02 Effect of Reversal and Non-Reversal Shifts on Successive Discrimination Learning: Compared to subjects who undergo no shift, subjects under reversal and non-reversal shift schedules show retarded subsequent learning with the non-reversal shift more retarded than reversal.

B-111 Buss (1953)+

8.4.03 Performance of Retardates on Discrimination Reversal: There is some evidence that retardates perform discrimination reversals quite readily.

H-162 House (1964).

M-176 Milgram and Furth (1964).

Interpolated Activity

10.0 Time Interval Between Tasks: Transfer of training remains roughly constant with varying intervals of time elapsing between the original and transfer tasks up to an interval of at least 90 days.

(Note: To speak of time interval here is to speak of unspecified activity that may not be homogeneous for all subjects and may range the continuum of facilitative to interfering influences).

M-036 McGeoch and Irion (1952) p. 339.

Also see: E-013 Ellis (1965) p. 39, 73.

B-097	Bunch (1936)+
B-102	Bunch and Lang (1939)+
B-105	Bunch and McCraven (1938)+
E-015	Ellis and Hunter (1960)+
E-016	Ellis and Hunter (1961)+
E-017	Ellis and Hunter (1961)+
G-035	Gladis (1960)+

10.0.1 Time Interval Between Tasks Under Conditions of Negative Transfer: Under conditions designed to yield negative transfer, the transfer effect has been found to vary with the passage of time. Negative transfer effects seem to be greatest after short time intervals, with the effect gradually shifting to positive transfer with longer intervals of time.

E-013 Ellis (1965) p. 41.

B-098 Bunch (1939)+

10.0.2 Effect of Keeping Same Response but Changing to Similar Stimulus After Different Time Intervals: Transfer declines with the passage of time if an A-B, C-B paradigm (same response to different but similar stimuli) is employed.

E-013 Ellis (1965) p. 41.

E-014 Ellis and Burnstein (1960)+

10.0.3 Effect of Time Interval Between Two Paired-Associate Learning Tasks on Learning the Second: As the period of rest between the learning tasks increases, performance on the new learning task decreases; that is, the transfer effect decreases. This decrease appears to approach a maximum with intervals of approximately one hour.

M-033 McGeoch and Irion (1952) p. 451.

H-003 Hamilton (1950)+
L-096 Luh (1922)+

10.0.4 Effect on Performance of Interpolated Rest Between Identical Simple Motor Tasks: Subjects' performance, in terms of mean score, seems to be an increasing function of the duration of interpolated rest (maximum rest of five minutes).

B-221 Bilodeau (1952)+

10.1 Interpolated Activity Between Tasks: Depending upon its nature, interpolated activity can facilitate or interfere with transfer from one task to a second.

A-045 Adams (1955) found interference.

10.1.1 Effect of Interval Between Termination of Interpolated Learning and Recall of Original Task: With recall of original task after interpolated learning, intrusions from the interpolated learning decrease as the time interval between termination of interpolated learning and recall increases.

B-186 Briggs (1954)+

D-051 Deese and Marder (1957)-

10.1.2 Effect of Environment on the Influence of Interpolated Activity: Interpolated material seems to lose some (up to one half) of its retroactive effect on recall of original task if it is learned under conditions markedly different from those of original learning.

B-034 Bilodeau and Schlosberg (1951)+

10.2 Reminiscence:

(a) Ward-Hovland Phenomenon: Reminiscence is a temporary improvement in performance not attributable to practice which appears over short intervals of time -- between two and five minutes.

O-008 Osgood (1953) p. 509.

(b) Ballard-Williams Phenomenon: Reminiscence is an improvement in performance without practice which appears after delays as great as two or more days.

O-008 Osgood (1953) p. 509.

Note: The most appropriate delay is not known; nevertheless many investigators have demonstrated the phenomenon; some of them are mentioned below including some who did not find reminiscence effects and they are so coded).

A-007 Ammons (1947)+

B-206 Ballard (1913)+

B-222 Barch (1952)+

B-215 Buxton (1943)+

D-075 Denny (1951)+

D-063 Dore and Hilgard (1937)+

D-064 Dore and Hilgard (1938)+

D-067 Duncan (1951)+

E-046	Estes (1950)+
G-129	Gray (1940)+
G-112	Grice and Reynolds (1952)+
H-156	Hovland (1938)+
H-157	Hovland (1938)+
H-158	Hovland (1939)+
I-002	Irion (1949)+
I-003	Irion and Gustafson (1952)+
K-088	Kimble and Horenstein (1948)+
L-098	Leavitt (1945)+
L-093	Leavitt and Schlosberg (1944)+
M-174	McClelland (1942)+
M-175	McClelland (1942)+
M-049	Melton (1941)+
H-173	Melton and Stone (1942)0
R-101	Reyna (1944)+
R-100	Rockway (1953)+
S-167	Shipley (1939)0
S-065	Snoddy (1935)+
W-003	Ward (1937)+
W-096	Williams (1926)+

10.2.1 Effect of Length of Interval on Reminiscence: Reminiscence is maximal after brief rest intervals, the most effective interval depending on the type of task but being limited to a few minutes.

O-008 Osgood (1953) p. 511.

G-112	Grice and Reynolds (1952)+	pursuit rotor task
I-002	Irion (1949)+	pursuit rotor task
K-088	Kimble and Horenstein (1948)+	pursuit rotor task
W-003	Ward (1937)+	serial anticipation task

10.2.2 Effect of Degree of Learning on Reminiscence: Learning to a moderate degree of mastery (about seventy-five percent) yields more reminiscence than learning to either a lower or a higher degree.

O-008 Osgood (1953) p. 511.

H-156	Hovland (1938)+	serial task
H-157	Hovland (1938)+	serial task

10.2.3 Effect of "Forcing" Conditions on Reminiscence: Conditions that force the subject, such as increasing the presentation rate of items or decreasing the inter-trial interval, facilitate reminiscence, and the effect is greatest in the central portions of serial lists.

O-008 Osgood (1953) p. 511.

Also see: M-036 McGeoch and Irion (1952) p. 169-171; H-067 Hovland (1951) p. 656.

H-156	Hovland (1938)+	serial task
H-157	Hovland (1938)+	serial task
M-174	McClelland (1942)+	serial task
R-101	Reyna (1944)+	serial task

10.2.4 Effect of Schedule of Practice on Task Upon Reminiscence:

Reminiscence gains become progressively smaller as inter-trial interval increases, and subjects on massed practice schedule display more reminiscence than subjects on a distributed schedule.

B-222	Barch (1952)+	pursuit rotor task
D-075	Denny (1951)S	pursuit rotor task
D-067	Duncan (1951)-	pursuit rotor task
E-046	Estes (1950)+	pursuit rotor task
H-156	Hovland (1938)+	serial task

10.2.5 Effect of Various Intervals in Combination with Various Types of Learner on Reminiscence:

Fast learners show greatest reminiscence with short interval, whereas slow learners show greatest reminiscence with a longer interval.

L-098 Leavitt (1945)+

10.2.6 Bilateral Transfer "Reminiscence": Bilateral transfer "reminiscence" occurs when an S trained on a task (in many cases a pursuit rotor task) with one hand is given a rest period and then switched to the other hand. S performs on the second task better than an S who switches to the other hand without a rest interval.

I-012	Irion (1952)+	rotary pursuit task

10.2.6.1 Effect of Amount of Rest on Bilateral Transfer Reminiscence: The gain in performance is an increasing function of the amount of rest.

G-112	Grice and Reynolds (1952)+
R-100	Rockway (1953)+

10.2.6.2 Effect of Amount of Pre-Rest Practice on Bilateral Transfer Reminiscence: Bilateral reminiscence is an increasing function of preferred hand practice (when the first task is the preferred hand task).

G-128	Gustafson (1953)S
R-100	Rockway (1953)+

Practice Effects

11.0 First Task Practice.

11.0.01.1 Effect of Amount of First Task Practice on Negative Transfer: In general, conditions yielding negative transfer do so when the training acitivity on the original task is learned to a relatively low degree. As training increases, the amount of negative transfer diminishes and may be superceded by positive transfer.

(See: 15.0 Learning to Learn).

M-036 McGeoch and Irion (1952) p. 337.

Also see: E-013 Ellis (1965) p. 43; Mandler (1962).

11.0.01.2 Effect of Amount of First Task Practice on Positive Transfer: The small amount of evidence available also shows that positive transfer increases as amount of first task practice increases.

M-036 McGeoch and Irion (1952) p. 337.

C-028 Cook (1936)+

D-035 Duncan (1953)+

D-070 Duncan and Underwood (1953)+

F-028	Fleishman and Hemple (1953)S
H-050	Ho (1928)+
S-050	Siipola and Israel (1933)+
U-004	Underwood (1949)+
U-005	Underwood (1951)+

11.0.02 Description of Function Between Amount of Practice and Transfer: A U-shaped function has been demonstrated between amount of practice and transfer.

M-159	Mandler (1962).
M-015	Mandler and Heineman (1956)+

11.1 Effect of Amount of Pre-Training on Transfer: Relevant pre-training has been found to result in positive transfer to both motor and verbal tasks.

(See: 6.6 Predifferentiation Training; 14.0 Warm-up)

C-002	Cantor (1955)+	verbal task
C-003	Cantor (1955)+	motor task
G-026	Gibson and Bergman (1954)+	perceptual task
K-024	Kendler and Vineberg (1954)+	verbal task
L-024	Lawrence and Goodwin (1954)+	motor task

11. 2 Effect of Type of Pre-Training on Transfer: Positive transfer effects to the subsequent learning of a motor task result from varying amounts of verbal pre-training.

B-142 Baker and Wylie (1950)+

G-042 Goss (1953)+

H-057 Holton and Goss (1956)+

M-027 McAllister (1953)+

11. 3 Amount of Practice and Whole-Part Learning Method: It has been shown that the advantage of the whole method over the part method increases with practice.

M-036 McGeoch and Irion (1952) p. 502.

Also see: H-067 Hovland (1951) p. 640-642.

B-058 Briggs and Brogden (1954)+

L-099 Lakenan (1913)+

S-177 Steffens (1900)+

W-098 Wylie (1928)+

11. 4 Early Task Learning and Transfer: Transfer is maximized if greater effort is spent in mastering the early task of a series that are related.

E-013 Ellis (1965) p. 73.

11.5 Familiarization: Familiarization training for the stimulus terms leads to positive transfer.

(See: 6.3 Predifferentiation Training).

C-079 Cieutat (1960)+

G-122 Gannon and Noble (1961)+

H-069 Hovland and Kurtz (1952)+

N-019 Noble (1955)+

R-094 Riley and Phillips (1959)+

U-020 Underwood and Schulz (1960)-

W-099 Waters (1939)-

11.6 Familiarization: Familiarization training for the response terms leads to positive transfer.

C-079 Cieutat (1960)+

G-122 Cannon and Noble (1961)+

H-069 Hovland and Kurtz (1952)+

N-019 Noble (1955)+

R-094 Riley and Phillips (1959)+

U-020 Underwood and Schulz (1960)+

W-099 Waters (1939)-

Task Characteristics

12.0 **Effect of Task Composition on Transfer**: Transfer from tasks in which elements are presented separately to tasks in which those elements are presented simultaneously as members of compounds usually result in lengthened reaction time.

G-120 Goss and Nodine (1965) p. 205.

H-145 Hill and Wickens (1962)-
M-166 Musgrave (1962)+
M-167 Musgrave and Cohen (1964)+
M-168 Musgrave, Goss and Shrader (1963)+
S-166 Shepard and Fogelsunger (1913)+

12.1 **Effect of Task Presentation Schedule on Transfer**: Transfer from tasks in which elements are presented simultaneously in compounds to tasks in which the elements are presented separately result in lengthened reaction time.

G-120 Goss and Nodine (1965) p. 206.

C-080 Cohen and Musgrave (1964)+
N-035 Newman and Taylor (1963)+

S-166 Shepard and Fogelsonger (1913)+

S-168 Sundland and Wickens (1962)M

U-021 Underwood, Ham and Ekstrand (1962)+

12.2 Effect of Subject Material on Transfer: Transfer of rate of memorizing from one material to a different one is usually positive, but relatively small in amount.

M-036 McGeoch and Irion (1952) p. 309.

K-009 Reed (1917)+

S-057 Sleight (1911)+

12.3 Effect of Mixed or Unmixed List Conditions on Transfer: There seems to be no difference in transfer as a function of whether or not a mixed or unmixed list is used in paired-associate learning.

H-143 Hall (1966) p. 477.

J-048 Johnson and Penney (1965)-

T-037 Twedt and Underwood (1959)+

12.4 Transfer and Task Difficulty: Keeping in mind that perhaps one of the most significant factors to be considered in transfer and task difficulty is the type or nature of the task involved, it has been demonstrated that both combinations (e.g., easy to hard; hard to easy) of task training have resulted in both types of transfer (e.g., positive and negative).

E-013	Ellis (1965) p. 45.

12.4 Transfer and Task Difficulty: Positive transfer is more likely to occur in going from an easier task to a harder task.

A-008	Ammons, Ammons and Morgan (1956)+
B-225	Baker and Osgood (1954)+
D-014	Deese (1958)-
G-052	Green (1955)0
G-037	Goldstein and Newton (1962)-
H-103	House and Zeaman (1960)+
K-048	Kreese, et al (1954)-
L-021	Lawrence (1952)+
L-024	Lawrence and Goodwin (1954)+
R-048	Restle (1955)+

12.4.1 Effect of Length of Task on Task Difficulty: A number of studies indicate that for both verbal and motor serial learning difficulty increases disproportionately with the number of components.

O-008 Osgood (1953) p. 513.

Also see: H-067 Hovland (1951) p. 620; M-036 McGeoch and Irion (1952) p. 489.

C-085 Cook (1937)+

E-049 Ebbinghans (1885)+

H-091 Husband (1931)+

M-039 McGeoch and Oberschelp (1930)+

12.4.2 Effect of Speed Variation in Pursuit-Rotor Learning on Transfer: It has been found that practicing at one speed on a pursuit-rotor device and transferring to another speed results in greater transfer effects the more similar the original task is to the transfer task. (See: 1.3 Stimulus Generalization; 7.0 and 7.0.1 Stimulus and Response Variation).

E-013 Ellis (1965) p. 45.

L-045 Lordahl and Archer (1958)+

N-002 Namikas and Archer (1960)M

12.5 Transfer and Task Complexity: In the case where transfer is from verbal pretraining to motor performance, positive transfer decreases as motor task complexity increases (e.g., number of fingers used on a finger-positioning task).

B-019 Battig (1956)+

12.6.1 **Transfer and Task Variety -- General Statement:** It has been demonstrated that amount of transfer increases as a direct function of increased variety of original training. However, the most marked increase in positive transfer appears to occur with only a small increase in the number of training tasks.

E-013 Ellis (1965) p. 44.

D-036 Duncan (1958)+
D-071 Duncan and Underwood (1954)+
D-072 Duncan and Underwood (1954)+
D-073 Duncan and Underwood (1954)M
D-074 Duncan and Underwood (1957)+

12.6.2 **Transfer and Task Variety -- Problem Solving:** Training with a variety of types of problems, rather than one type of problem, tends to produce more effective transfer.

A-001 Adams (1954)-
C-051 Callantine and Warren (1955)+
G-125 Gagne and Bassler (1963)+

H-111 Hull (1920)+

M-079 Morrisett and Hovland (1959)+

S-173 Shore and Sechrest (1961)+

12.6.3 Interference and Task Variety: Interference effects are reduced by frequent shifts from one task to the other.

M-036 McGeoch and Irion (1952) p. 338.

B-003 Bain (1902)+

M-105 Munsterberg (1889)+

12.7 Transfer and Task Similarity: In general, the greater the degree of similarity between two tasks, the greater the amount of positive transfer obtained.

E-013 Ellis (1965)

A-033 Adams (1954)+

P-023 Poffenberger (1915)+

S-004 Salisbury (1934)+

S-049 Siipola (1941)+

S-082 Starch (1911)+

Transfer and Task Similarity: Thorndike and Woodworth (1901) concluded that transfer of training was limited to those situations in which the two tasks contained "identical elements."

12.8 **Meaningfulness and Transfer:** It has been suggested that in verbal learning, meaningfulness facilitates the rate of learning but has no effect on transfer.

E-013 Ellis (1965) p. 45.

M-063 Miller and Selfridge (1950)O
N-011 Noble (1959)+

Learner Factors

13.0 Age and Retroactive Inhibition: There is some evidence that the amount of inhibition decreases with increasing CA from eight to sixteen years of age.

M-036 McGeoch & Irion (1952).

L-004 Lahey (1937)+

13.1 Age and Motor Task Learning: It has been demonstrated that when Ss learn one motor task and then another they show less loss with age if the second task does not require them to learn conflicting responses.

H-067 Hovland (1951) p. 633.

R-102 Ruch (1934)+

13.2 Intelligence and Transfer: Some investigators have found that more intelligent students show greater transfer.

E-013 Ellis (1965) p. 65.

C-039 Craig (1953)+

W-039 Werner (1930)+

13.3 Motivation.

13.3.1 **Motivation and Paired-Associate Learning:** It has been found that in paired-associate nonsense-syllable learning "high-anxiety" subjects take more trials to master the second learning task (anxiety-producing instructions were injected between the two tasks) than "low anxiety" subjects.

13.3.2 **Motivation and Motor Learning:** Motivated improvement on a motor task has been shown to transfer bilaterally.

F-001 Fairclough (1952)+

13.4 MA and IQ Factors.

13.4.1 **Comparison of Performance of Normal and Retardates:** It would seem that although retardates' performance is consistently poorer when compared to that of normal children, the retardates do show significant amounts of positive transfer in many learning situations.

B-219 Baumeister, Beedle and Hawkins (1964)S

H-161 Harter (1965)S

13.4.2 Retardate Studies on Transfer and Associated Topics:

E-050	Evens (1964)
G-132	Green and Terrell (1963)
H-152	House (1964)
H-153	House (1964)
H-162	House (1964)
M-176	Milgram and Furth (1964)

Warm-Up

14.0 Warm-Up: Warm-up is the pronounced but temporary facilitating effect resulting from practice in some activity prior to learning the transfer task.

(See: 11 Practice Effects)

E-013 Ellis (1965) p. 73.

H-035 Heron (1928)+

M-163 Mitchell (1933)-

14.1 Effect of Warm-Up on Level of Practice: Rate of learning seems to be directly related to the number of warm-up trials.

M-109 Mandler (1956)+

14.2 Type of Task and Warm-Up.

14.2.1 Verbal Tasks.

14.2.1.1 Effect of Level of Practice on Warm-Up: Warm-up gain has been shown to be relatively independent of and consistently larger than the general practice effect.

T-042 Thune (1951)+

14.2.1.2 Effect of Warm-Up on Relearning: Amount of recovery from retention loss seems to be an increasing function of amount of pre-recall warming-up. The rate of rise of the relearning function tends to be greater following small than following large amounts of pre-recall warming-up activity.

I-004 Irion and Wham (1951)+

14.2.1.3 Effect of Warm-Up on Recall: Performance of one recall task facilitates the performance of a subsequent and similar, but not identical, recall task, provided the two tasks occur within a relatively short time of each other.

H-140 Hunter (1955)+

14.2.1.4 Efficiency of Warm-Up in Learning Test Task: The facilitating effects of preliminary warm-up practice appear to be most prominent during the first few learning trials on the test list. (paired-associate list)

T-023 Thune (1950)+

14.2.2 Motor Tasks - Pursuit Rotor.

14.2.2.1 Warm-Up Decrement and Practice Schedule: Warm-up decrements have been found under both massed and distributed practice, the decrement tending to decrease for distributed practice.

A-075 Adams (1950)+

A-076 Adams (1952)+

A-050 Ammons (1955)S

14.2.2.2 Effect of Warm-Up on Rotary-Pursuit Performance: Different conditions of warm-up activity as used by Ammons (1951) resulted in no differences in scores of the subjects on the preceding task.

A-077 Ammons (1951)

Learning to Learn

15.0 Learning to Learn: Practice on successive samples of the same kind of material is accompanied by an increase in rate of learning.

M-035 McGeoch (1942) p. 399.

Also see: E-013 Ellis (1965) p. 73; M-036 McGeoch and Irion (1952) p. 122-361.

B-100 Bunch (1941)+

D-037 Duncan (1960)+

L-029 Lepley (1934)+

H-014 Harlow (1949)+

K-053 Kauffman and Peterson (1958)+

M-161 Meyer and Miles (1953)+

P-061 Postman (1964)+

W-003 Ward (1937)+

15.1 Learning Set: In many areas of learning, practice on a series of learning tasks leads to an improvement of the subject's ability to deal with the particular learning situations involved.

K-032 Kimble (1961) p. 385.

C-051 Callantine and Warren (1955)+

H-165 House and Zeaman (1959)+

S-043 Shepard (1957)+

15.1.1 Factors Which Influence Formation of Learning Sets:

15.1.1.1 Effect of Early Trials on Formation of Learning Set: Early trials are extremely significant in establishing a reliable learning-set. If practice with a particular type of problem is discontinued before it is reliably learned, then little transfer will occur to the next series of problems.

H-166 Harlow (1959).

15.1.1.2 Effect of Conditioning and Extinction on the Formation of Learning Sets: Repeated conditioning and extinction increase the rapidity with which the processes of formation of learning sets occur.

K-032 Kimble (1961) p. 385.

B-213 Bullock and Smith (1953)+

15.1.1.3 Type of Subject and Formation of Learning Sets: The formation of learning sets is more rapid in either normal or mentally defective (IQ 50-75) children than it is in the rhesus monkey, squirrel monkey, or marmoset.

K-032 Kimble (1961) p. 387.

15.1.2 Transfer and Learning Set: If, prior to learning, set to perform is induced, rate of learning should be greater than if this set had not been induced. Amount of this increase in the rate of acquisition should be an increasing function of (1) the similarity between the set-inducing task and the learning task, (2) the amount of time devoted to the induction of appropriate set, and (3) the inverse function of the time between the two activities.

M-036 McGeoch and Irion (1952) p. 334.

15.1.3 Function of Learning Set for Subject: The set of subject directs him toward an attack upon a rational problem; it also determines to a considerable extent what prior knowledge he shall bring to bear on it and how he shall attack it.

M-036 McGeoch and Irion (1952) p. 226.

L-046	Luchins (1942)+
P-033	Pratt (1928)+
S-035	Sells (1936)+

15.2 Insight or Discovery: Insight, defined behaviorally as the rapid solution of problems, appears to develop as a result of extensive practice in solving similar or related classes of problems.

E-013 Ellis (1965) p. 35.

H-014 Harlow (1949)+

15.2.1 Variable Behavior and Discovery: The more variable the behavior, the more likely it is that an adequate response will be discovered.

M-036 McGeoch and Irion (1952) p. 572.

Also see: O-008 Osgood (1953) p. 637.

15.2.2 Discovery and Transfer: Transfer to new task may be better if in learning, the learner can discover relationships for himself.

H-133 Hilgard (1956).

W-099 Wolf (1963)-

CHAPTER IV
PROJECT OBJECTIVES

OBJECTIVE 1: HYPOTHESES ABOUT THE NATURE OF TRANSFER AND VARIABLES AFFECTING IT

Two Types of Transfer

Specific Transfer

The type of transfer dealt with by Thorndike and Woodworth (1901) is the psychological process that is evidenced by performance on a later task which has elements in common with a task learned earlier. Three varieties of intertask relationships can be identified in terms of transfer effects as revealed by performance differences between experimental and control groups since the student who learned the first task, as contrasted with the one who didn't, can perform better, worse or no differently on the second task. The apparent carry-over of the effects of prior learning is called transfer of training. Those situations in which transfer may be associated with intertask relationships, involving common features or elements of the stimulus materials or the responses (specific transfer), have been studied more extensively than those in which the stimuli or responses are not obviously common to the two tasks.

Osgood (1949; 1953) attempted to consolidate the data obtained from several separate sets of intertask relationships. His representation is presented in the transfer and retroactive surface in Fig. 1. Bugelski and Cadwallader (1956) studied several of the same conditions of transfer and retroaction and found both supporting and contradictory evidence for the Osgood surface. The results of their study relate to what was described as the Skaggs-Robinson hypothesis (see McGeoch and Irion, 1952). These findings are summarized in Fig. 2, a current version of the transfer and retroaction

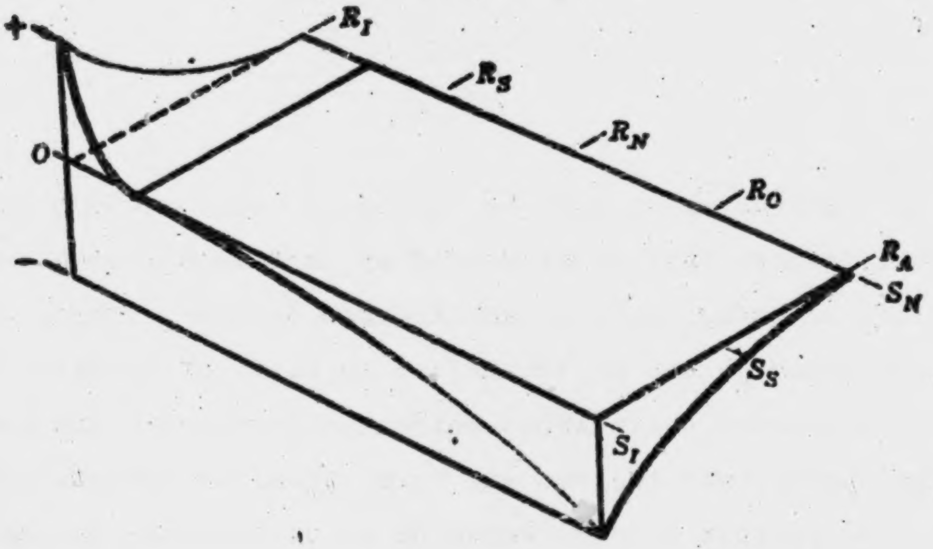
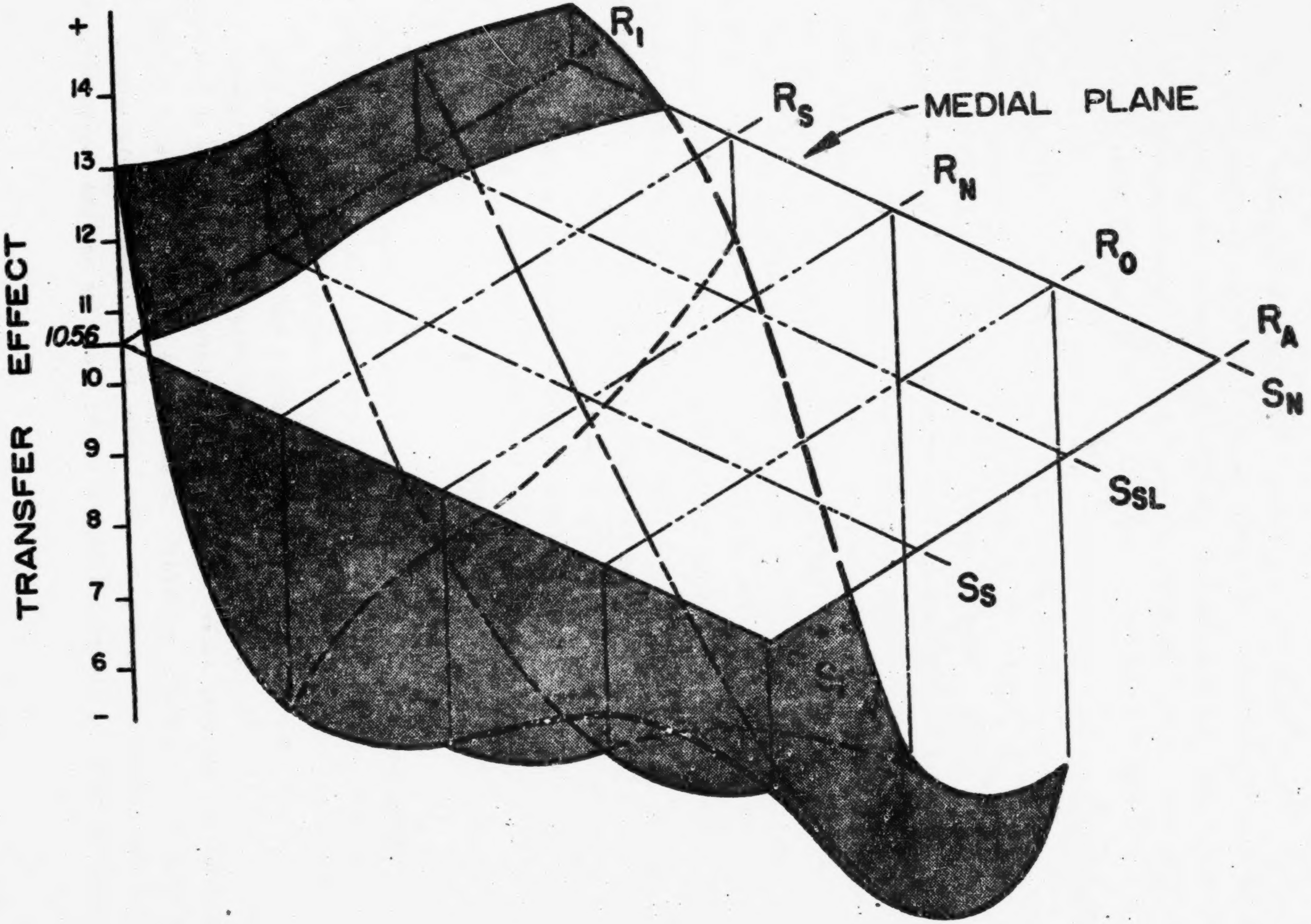


Fig. 1. Transfer and retroaction surface: medial plane represents effects of zero magnitude; response relations distributed along length of solid and stimulus relations along width. Osgood, Psychological Review, 1949, 56, 140.


TRANSFER EFFECT
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S_S

Fig. 2. Revised transfer and retroactive surface, based on Bugelski, B. R., and Cadwallader, T. C. Journal of Experimental Psychology, 1956, 52, p. 362.

surface. The relationships depicted in Fig. 1 may be both less commonly found in non-laboratory situations and less interesting as educational phenomena than those involved in non-specific transfer. Since specific transfer is described and well documented in many available references (e.g., McGeoch and Irion, 1952; Osgood, 1953; Ellis, 1965), it will not be explicated here.

Non-Specific Transfer

The more ubiquitous, though less often studied form, is non-specific transfer. It is transfer which appears to be relatable to derived features common to two tasks. The most elementary form is mediated stimulus generalization. In addition, responses can be cued by relational, structural, and/or formal (abstract) features of stimulus materials, features not usually represented in a single discriminable element present in two different tasks. When neither the stimuli nor the responses are common or even similar in the two tasks, transfer nevertheless can take place. An explanation of this is possible in terms of mediation theory (e.g., Osgood, 1953). Responses made to two tasks and representing transfer can be cued by stimulus relationships described as analogies, metaphors, algorithms, congruities, and incongruities. Non-specific transfer is assumed to be mediated by a process (either a response or a set of responses) which serves to relate perceptually distinctive and often perceptually different materials to common behavioral outcomes. When such materials are alleged to be conceptually similar, this is implied evidence of a common mediating response.

Approach

A useful beginning for a research program in this area is with the data, methods, and concepts of transfer as they have been developed from the common elements point of view. It is assumed, however, that this is insufficient for education since the data, concepts and principles generated would be too limited. Omitted would be relationships between abilities or aptitudes and learning scores obtained from performance on courses of instruction and data on non-specific transfer. To extend the work in ways useful to education two assumptions were made. One, there is a fundamental relationship between the learning theorist's conception of mediation and the psychometrician's conception of abilities and two, there are at least three basic characteristics of complex tasks (quality, texture and structure) which determine transfer effects occuring both within and between the tasks.

The first assumption is based upon a logical analysis of the concept of mediation as an association (or set of associations) that links an explicit set of stimuli to a set of responses and upon the definition of ability as something a person does in the presence of a specified set, or type, of materials, which predicts future achievement in a number of situations of a specified type.

The second assumption can be analyzed similarly. Briefly, it is that transfer may be viewed as a process in which performance is mediated and the cues for responses include both those that do and do not have common identical elements --- physical and formal similarities.

In addition to the intertask situations to which the common elements conception applies, there are intertask situations in which transfer occurs but for which there are no common perceptual elements. Consequently, an alternative view is needed which can be called a generalized-process conception of transfer. It is a more general conception of the mechanisms accounting for transfer since it embraces formal or relational communalities as well as perceptual ones. It assumes not only that stimuli which contain class-descriptive cues (Stolurow, 1956) may be associated with a common response but also that perceptually dissimilar stimuli can become cues of common responses. The feature common to two tasks which could account for the observed transfer effects (either positive or negative) is a common response (e.g., a metaphor) that was learned. This mediational conception of transfer explicitly deals with intertask relationships that can be described as formal similarities, (e.g., metaphors, analogy) as responses which have cue value.

Specific and Non-Specific Transfer

It is assumed that the mechanisms which account for transfer are of two basic kinds. One kind is content specific and usually is studied in research relating to the common elements theory of transfer (Thorndike and Woodworth, 1901). The other kind is process specific and usually is studied in relation to a skill. Therefore, the distinction between the types of transfer (specific and non-specific) depends upon the nature of the relationship between, or among, a set of tasks. With the tasks used in the research on the common elements theory of transfer there are readily identifiable physical elements common to the tasks. An example is the number of letters common to two or more words.

In Harlow's learning-set studies (1949), however, the relationship is not a common cue-stumulus but, rather, a common confirmation stimulus which follows the learner's response and is contingent upon the nature of the response. The cue stimulus materials (discriminanda) used in Harlow's discrimination learning-set studies do not have a particular perceptual element running through the set of paired objects (e.g., red color or round form). Instead, the stimulus characteristics of the objects can vary from pair to pair. In fact, if an element were common to an object in each of two or more sets, it would change the transfer task to a common elements condition. When no element is held in common, two processes or sets of associations are developed. One is involved in learning each specific discrimination; each discrimination involving "junk stimuli" teaches the student that one, and only one, stimulus object in every pair is followed by a reinforcement stimulus. Once this contingency is learned, the student is shown any new pair of objects, selects one, and, if he obtains reinforcement, continues to select that member of the pair. If, however, his response is not reinforced, then he inhibits that response and selects the other stimulus object on the next trial. The cue to persist in his original selection is the presence of the reinforcement stimulus following his response; the cue to change to the other object is the absence of the reinforcement. Thus, once he has learned that only one object is followed by reinforcement, only one trial is needed to solve any new discrimination. In this type of learning the common element is not in the discriminanda (the stimuli preceding the response) but rather in the reinforcement, or confirmation stimulus, the stimulus that follows and reveals its correctness to the learner. The fact that the critical aspect of the cue is response dependent, rather than an aspect of the discriminanda, makes the process one that is learned slowly but for which the transfer is more general.

A Generalized-Process View of Transfer of Training

The basic studies contributing to a generalized view of transfer of training include two or more tasks for the learner, each of which involves forms of stimuli that are relatable in terms of common formal elements. They also include intertask conditions that are describable in terms of common physical or perceptual elements which serve as cues. Studies of cumulative transfer are relevant to this view since the student is confronted with a set of tasks, homogeneous with respect to their formal properties, from which he can acquire "learning sets" (see Harlow, 1949; Gagné and Paradise, 1961). In other words, the task matrix, the formal characteristics of the task, in which the stimuli are imbedded (Grant, 1964) is the same from task to task but the stimuli vary (e.g., discriminate a circle and square, a toy car and doll). From working with a set of problems that can be said to be homogeneous, the student learns to respond in a particular way to a set of objects in a specific context. Homogeneity of problems, as used in this context, refers to a formal similarity among a set of learning tasks, e.g., the discrimination of object quality or of oddity among sets of these objects.

Quality, Texture and Structure

Each particular set of associations which a learner acquires (e.g., select circle) constitutes what is meant by the qualitative nature of the learning that has taken place. Learning sets, on the other hand, are associations that are common to a variety of physically different but formally related stimuli. One type of mediating relationship among stimuli involved in associations is called attitudinal; this type involves both sets of objects, or symbols, as cues and their affective or emotional responses. This type of mediating mechanism is dispositional in the sense that it primarily involves approach or avoidance responses (possibly covert) to specific cues or to classes of cues. Another type is psychomotor; this involves both perceptual stimuli as cues, and overt or observable motor responses. This type of learning set consists of skills and generally involves visible, overt responses. A third type is cognitive; this involves both sets of cues and responses that produce stimuli which have meaning for other persons. This type of learning set is substantive in nature in the sense that the critical cues and responses are content related.

A particular group of learning sets, of whatever type or types, that is the distinctive qualitative set acquired by a learner, is the texture of his learned behavior. Learners may acquire a number of learning sets that are qualitatively the same, e.g. to discriminate circle and square, but they may differ from each other in the textures or mediating connections. For example, one student may not acquire the attitudinal set acquired by the other although both were taught the same discrimination task. The texture of behavior which the student learns may include one or more of the possible qualitatively-different learning sets. Thus, two students learning the same task may acquire behaviors which differ in texture; they may earn the same score on a test of achievement because each may acquire the same number of learning sets although not the same learning sets. Mastery of a task increases the probability that all learners have repertoires with the same texture. Below-mastery compensation or trade-off is possible, and a summary score does not reveal the differences in texture.

In the learning of complex behavior repertoires, it is assumed that students will acquire qualitative components at different rates. Hence, the texture of their repertoires at any point in time will show considerable variation in concepts (content learning set), attitudes, strategies (methods of attack), and possibly some psychomotor skills. Different learners actually will acquire the individual learning sets to varying degrees of proficiency if they all are taught in the same way. Thus, the development of learning sets is a variable outcome of the particular learning experiences provided the learner, and methods of providing them will differ in the range of variation produced among a group of learners. While the individual learning sets are mastered to different degrees, those that are mastered to minimal criteria levels constitute the qualitative elements of the learner's repertoire and thereby its behavior texture. The texture of a learner's behavior, however, does not specify interrelationships among the qualitative elements.

Hierarchical transfer is transfer from lower-level learning sets to higher-level learning sets within a subject matter domain. The structure of behavior refers to the interrelationships among learning sets such as hierarchical relationships which exist among a group of learning sets (e.g., Gagné and Paradise, 1961; Merrill, 1965). Each hierarchy of learning sets has a pattern and a distinctive form which is a result of the conditions of learning and the degree of overlearning and is specified by the cueing of textural elements. Qualitative learning sets, including content, attitudinal, and psychomotor types, all may be involved in a particular hierarchical structure. Each, presumably, is cued to at least one of the others in a pattern that is sequential or represented by a hierarchy. It is assumed that a hierarchy of learning sets is developed through cueing; the pattern of interrelationship which develops for a particular learner, however, may not agree with the formal analysis of the subject matter and the intent of the teacher.

Furthermore, the learning sets may not develop from lower to higher levels and, in fact, probably will not unless the conditions of learning, particularly the sequences, are properly engineered. An example of ineffective cueing of learning sets has been reported by Stolurow, Hodgson, and Silva (1956). Whether the particular learning sets that give behavior its texture also constitute an associative structure depends upon the extent to which the constituent learning sets are cued to one another. If they are not, then the behavior has texture but not structure.

Aptitudes, Mediation Processes, and Transfer

In formulating a model of individual teaching which can accommodate this conception of transfer, it was assumed that the processes measured by ability tests and the processes postulated by the learning theorist (to account for the acquisition and transfer of knowledge and skills) were the same. In this respect, the model is consonant with the theoretical positions of Ferguson (1954, 1956); Osgood (1953); and Guilford (1950). The underlying hypothesis is that when the skills and mechanisms developed while learning a variety of tasks with a common structure are overlearned, they become the abilities and aptitudes that are measured by tests of individual differences. From sets of structurally-related tasks, the learner learns how to learn (e.g., Harlow, 1949) tasks of that type which means he more readily can acquire new cue-response relationships involving the same formal property. It is further assumed that a great deal of the learning-how-to-learn effect is achieved simply because the same processing skills are involved in all the tasks. Thus, the transfer effects are due to something other than common perceptual elements. Consistent with Ferguson's position, it is assumed that overlearning brings these patterns of behavior to a level at which they become relatively invariant, and at some minimal level of invariance these behavior patterns can become apparent through performance on tests which are called ability and aptitude tests. The contribution of these relatively invariant behavior patterns to the learning of new associations is their transfer effect. Thus, aptitude and transfer are highly-related; aptitude is the potential for transfer that the individual acquires trrough learning. It is the set of cue-performance relationships that predicts future performance on a new task or, in other words, the current abilities that predict performance on a new task.

Processing Skills

It is assumed that all learning involves mechanisms which can be called processing skills. These skills aid the learner in acquiring associations in structurally-similar situations as well as in those containing common perceptual elements. Included are receptor orientating skills, e.g., eye movements.

Overlearning of processing skills comes about by the learning of specific skills which fall into classes or sets of experiences which, while they may differ in detail, nevertheless involve common formal elements such as represented by the simple, and now classic, cases of transposition and oddity. The development of learning sets, despite the variety of stimulus conditions (cue-response learning), is explained by the presence of cue-response sets which have some formal or relational elements in common. While this appears to be a reasonable hypothesis, as suggested by the research on learning sets of Harlow (1949), the actual mechanism which provides a sufficient behavioral condition represented by the common formal property (by oddity problems, for example) is not always easy to identify. In the discrimination learning set, for example, the learner simply responds to individual features of the displays, or to sets of them, as cues. If he is correct, he continues to use the cue; if he is wrong, he shifts to another cue. In other words, knowing that one is wrong means that another characteristic of the stimulus set is to be used as a cue.

Types of Molar Cues

There are several types of molar cues which the student learns initially as stimulus-response associations. Once learned, they serve to cue other responses. These are the common structural features of a variety of tasks.

Response dependency of reinforcement as a task characteristic. In addition to the several characteristics of tasks previously identified (Stolurow, 1964), the presence or absence of reinforcement can be a critical task cue. In other words, for some tasks, the sufficient cue is in the stimuli preceding response, whereas for others it is also the stimuli which follows the response.

Formal similarity can act as a cue. The critical aspects of a set of stimuli may be the common context in which they appear as well as in the events following response. A structural feature of tasks (a relationship between or among stimuli) can acquire a cue function in the same way the physical property of an object does. A structural feature can be a cue and can elicit a response or a response chain; the set of stimuli that are the structural features of a task can account for transfer from otherwise dissimilar-appearing tasks.

Verbal pattern as a cue. There are many structural characteristics of tasks such as forms in music, poetry, or prose (e.g., a chord, a sonata, a sonnet, a simple declarative sentence, a dialogue). Each of these can become a cue or an aspect of a complex cue for a particular response as is evidenced by the sheer fact that these forms can be reliably discriminated. The structure of a task can be a cue for response and is potentially useful as a basis for transfer. It can serve as the common element between or among a set of otherwise dissimilar tasks in the same way as does a physical or perceptual characteristic which is common to a set of tasks. The structures of grammar, mathematical proofs, and syllogisms, for example, while more difficult to discriminate, nevertheless illustrate the potential cue value of formal properties in transfer. Their actual significance for transfer is not well known since they have been neglected as the focus of research on transfer.

The structural features of tasks, however, have the potentiality of functioning in the development of important learning sets. The relative potency of structural features of tasks depends upon both the development of important learning sets and the relative salience of the critical features as compared with the perceptual features with which they are in competition for the learner's attention. Furthermore, if the structural features of tasks are to become cues, then two or more sets of stimuli have to be combined since structural features are coded as a relationship (e.g., syllogism). Memory also is involved since the discriminandum has to be recognized as having been associated with reinforcement.

Structural features as cues. The structural characteristics of tasks can be studied as the common element which accounts for transfer from otherwise apparently diverse learning experiences. For example, Crutchfield and Covington's (1963) successful use of programed-learning experiences involving mystery stories, as a means of improving the problem-solving performance of students on Dunker types of tasks (which have no common content with the learning experiences), illustrates the potential transfer value of skills cued by formal or structural characteristics of the learning experiences in spite of semantic differences.

Learner supplied labels as cues. Even the labeling of something as a problem can elicit the repertoire of problem-solving responses which the learner has acquired. A label identifies a structural communality that can be the cue for responses. In fact, the label can serve as a symbol representing the more complex formal similarity. The responses elicited may be simple or complex, sufficient or insufficient. Whatever their state of development and complexity, the responses elicited initially may lead to still other behaviors not previously associated with the task stimuli themselves. The task stimuli, plus the consequences of initial response to them, may produce solutions to problems (e.g., the algorithms of mathematics) simply because of a formal relationship among the stimuli which cues the required performance. While the verbal statement of the problem and the numerals they contain may be new to the learner, the relationship may be recognized as something that he has learned to label as a mathematical problem requiring the use of linear equations. This could be a sufficient cue to produce a complex set of responses involving information or data processing not previously practiced in the presence of the stimuli.

Included among the elicited responses are attention or receptor focusing skills and processing skills, many of which can be described in terms of formulas, algorithms or as rules or principles. Each of these, though complex in itself, nevertheless can be an element of a more complex response.

Behavioral Structures

Originality. A number of experimenters [Royce (1898); Slosson and Downey (1922); Osborn (1957); Maier (1931, 1933); Judson, Cofer and Gelfand (1956); Maltzman, Brooks, Bogartz, and Summers (1958); and Bass, Hatton and McHale (1962)] have investigated various training procedures in attempts to increase the frequency of original behavior. Thus, originality (often considered an aspect of creativity), as a form of performance on a variety of tasks, has been considered a transfer phenomenon as well as a human ability (Guilford, 1950). It is another example of non-specific transfer. Unlike the previous examples, it can transcend subject-matter boundaries.

Aptitudes, as treated here, however, are information-processing abilities which apply to sets of tasks having a common structural, or relational, characteristic. Originality is therefore considered an aptitude, one involving abilities which generate a multiplicity of associations to a stimulus rather than a single association. This form of behavior can be elicited by a wide range of stimuli which do not relate necessarily to one another as elements of a content area. It can be cued by structural features of tasks that do not relate necessarily to one another semantically.

Logical skills. There are other task structures which elicit complex behavior chains or processing skills. One example of logical or reasoning skills is the syllogism of logic. Syllogistic structures have been studied and formalized, and, interestingly, there is a finite set of 256 syllogisms to which as few as four rules of validity can be applied. Thus, once an argument is identified as a syllogism, these rules can be applied to determine the argument's validity whether it is presented in abstract or concrete form and, if in concrete form, regardless of the subject matter.

In transferring the information-processing skills involved in applying the rules of validity, the learner has to identify a complex structure (a set of relations among symbols) as a syllogism. To do this he may have to use other processing skills to translate words into symbols or to restate sentences. These processing skills are abilities which comprise the lower-level supporting skills involved in the ability mechanism for transfer in problem-solving whether it occurs in history, political science, or interpersonal relationships.

SUMMARY

The first phase of this project consisted of a survey of the existent data and concepts on transfer of training. It had two purposes: (1) to summarize and integrate research and theory and consolidate and interpret research findings, and (2) to consider these findings in relation to the problems of education so as to produce a set of hypotheses for research and a workable plan for conducting studies which relate to one another in a way that contributes to particular educational problems.

The procedure for Phase I involved library research plus an analysis and synthesis of existing information and concepts. Reports, articles, monographs, and books were abstracted and an interpretive summary prepared.

Preliminary empirical research was conducted using such instructional materials as logic, multiple correlation, and an artificial science. These empirical studies have dealt with the following basic problems in transfer: (1) sequencing, e.g., inductive (discovery) vs. deductive; (2) learning-how-to-learn; and (3) mediation.

The following sections present the summarizations of research and theory, of the preliminary studies relating to this plan, the research plan generated by the work performed during Phase I, and the work performed under Phase 2.

CHAPTER V
TRANSFER STUDIES

INFORMATION, ENCODING AND VERBAL MEDIATION IN TRANSFER OF TRAINING ON A PROBLEM SOLVING TASK

A series of experiments was conducted to investigate the effects of two basic types of transfer of training in complex concept-formation tasks. Two tasks were used which differed only in minor respects since each was generated from the same multiple-correlational model (Azuma, 1960; Azuma and Cronbach, 1961; and Cronbach and Azuma, 1961). The two basic types of transfer of training were: (1) transfer to task performance from written instructions which differed in the amount of information given the learner and (2) transfer from one task to the other where the relationships between tasks were specified. The latter included both two-stage and cumulative-transfer (learning-how-to-learn) experiments. The study was designed to investigate several basic problems such as (1) the informational value of different task characteristics, (2) the effects of different ways of encoding task-relevant information, and (3) the development and role of verbal mediating mechanisms (hypotheses) of the learner both when learning and when transferring to new tasks.

Amount of Information Conveyed by a Knowledge of Either the Principle or the Cues Given in Algebraic Form: Study I.

Reference: McHale, T. J. and Stolurow, L. M. More Information — Cues or Principles? Urbana, Ill.: University of Illinois, Training Research Laboratory, U. S. Office of Education, Contract 2-20-003, Tech. Rep. No. 5, May, 1964.

Type of Study: Experimental.

Problem: This experiment was designed to investigate (a) the amounts of information communicated by the knowledge of a principle as opposed to the knowledge of cues, and (b) the effectiveness of a principle as opposed to the knowledge of cues at different stages of learning.

Hypotheses. The hypotheses were: (1) knowledge of the principle is more beneficial than a knowledge of the cues since it is easier to learn the cues than it is to learn their proper weighting and formal relationship (principle); (2) knowledge of the cues is more beneficial in the early stages of learning when the S must detect what is relevant. A knowledge of the principle is more beneficial in the later stages of learning when the S must determine the appropriate weights and relationships for the relevant cues; and (3) the rank order of performance for the four different groups to be tested is full information, principle information, cue information, and no information.

Materials: A 2.5" x 2.5"square with a small red cross and a small green cross drawn inside of it. The left side of the scale, and the bottom of the scale represent coordinated axes. The location of each cross is specified by its distance from the left side and the bottom of the scale. These distances are its coordinated values. Each of the four coordinates (x', y', x", y") could take on one of four values: 3, 6, 9 or 12, corresponding to actual distances of .5, 1.0, 1.5, 2.0 inches, respectively.

Subjects: Fifty-two undergraduates in psychology at the University of Illinois, with 13 *Ss* in each of four groups. Thirty-eight *Ss* were administered the task during a regular class period; the other 14 *Ss* were obtained from a pool and were administered the task in small groups. Of the latter, four were in the cue group, four in the full information group and six in the principle group.

Procedure: One hundred and twenty-eight stimuli were presented -- 6 per page -- and each stimulus constituted a trial. The answer sheet contained 10 numbers for each trial, one for each of the possible numerical answers. *S* drew an "X" through the appropriate number. Verbal feedback in the form of the correct number was given at the end of each trial. The 128 trials can be analyzed into 8 sets of 16 presentations each, with every set having 16 possible

Procedure (cont'd): combinations of x' and x", each appearing only once. Therefore, $r_{x'x''} = .00$. Distributions of y' and y" were very close to rectangular and the correlations between x' and y' and x" and y' and x" and y" did not exceed .12 in any instance. For practical purposes, these variables can be considered uncorrelated.

Findings: The following conclusions about the three hypotheses were drawn:

1. A knowledge of the principle (principle group) is not more beneficial than a knowledge of the cues (cue group), although a knowledge of the principle together with a knowledge of the cues (full information group) leads to better performance; the final level of performance for the full information group, however, is not statistically better than that of the cue group.

2. When the principle and cue groups are compared, a knowledge of the cue does not seem to be more beneficial initially, nor does a knowledge of the principle seem to be more beneficial later in learning. However, the groups who knew the principle (full information and principle groups) did learn the relative importance of the two relevant cues better than the other groups.

Procedure(cont'd): 3. The rank order of performance for the four groups was not as predicted, since the cue group performed better than the principle group. The difference between the two groups, however, was not significant.

Amount of Information Conveyed by a Knowledge of Either the Principle or the Cues Given in Algebraic Form: Study II

Reference:	Stolurow, L. M. and McHale, T. J.
Status:	Completed.
Type of Study:	Experimental

Problem: The first study suggested that the presence of information about the task principle does no more to facilitate performance than does the absence of information, whereas information about the critical cues does facilitate performance. Furthermore, in a written questionnaire administered at the end of the task, many of the Ss verbalized their solutions of the task in a geometric form, whereas the original information was given in algebraic form. These verbalizations suggested that information given in geometric form might be more beneficial to the learner, since the geometric form of encoding seemed to facilitate performance.

Hypotheses: The hypotheses were: (1) cue information leads to better overall group performance than principle information although a knowledge of both cue and principle is a requisite for criterion performance; (2) whenever two groups are given the same information encoded in algebraic and geometric form, the group given the geometric encoding performs better; and (3) the rank order of performance is full information, cue information, principle information and no information.

Materials: Identical with those used in the immediately-foregoing study.

Subjects: The Ss were University of Illinois students from an introductory psychology class. Their participation was the class requirement. The task was administered to Ss in groups which ranged in size from 3 to 20. With the larger groups, two or three Es helped with the administration. There were 15 Ss in each experimental group for a total of 120 Ss. There were *seven* groups in the basic design of this study (an eighth group was run in an auxiliary experiment which will be discussed). One group was given no information. There were two assortments of principle, cue and full-information groups. One assortment was given information in algebraic form, the other in geometric form. This design allowed a comparison of principle vs. cue information, and of the algebraic vs. geometric encoding of information.

Procedure: The task stimuli and presentations were the same as in the foregoing study except that there were 160 stimulus displays, or trials, and Ss were paced. Twenty seconds were allowed for each trial.

Findings: Seven different, but perfectly correlated, rules (principles) were offered by Ss who solved the task. Types of rules they discovered could be related easily to the written

Findings: (cont'd.): instructions given before the task. It is clear that Ss do not benefit equally from the different content, or from different encoding of the content provided as pretask information. The correlational analysis of the data leads to the following conclusions about the hypotheses:

1. As in the previous experiment, there was an overall performance superiority of the cue groups.

2. There were no overall differences between the groups given the geometric and those given the algebraic information. However, the geometric groups tended to do a little better with full and with cue information and a little worse with principle information.

3. The predicted rank order of performance was confirmed; i.e., full information was followed by cue information and there were no significant differences between the principle information and no information groups. The likelihood of this rank order of groups occurring by chance is less than .05.

A Comparison of Transfer Effects From Written Instructions Under Paced and Self-Paced Conditions

Reference: Stolurow, L. M. and McHale, T. J.

Status: Completed.

Type of Study: Experimental.

Problem: This study was basically a replication of some of the groups in the previous study (Amount of Information Conveyed by a Knowledge of Either the Principle or the Cues Given on Algebraic Form: Study II.). In this study, however, each S worked at a teaching machine and, consequently, was self-paced. Comparisons were possible, therefore, between a paced and a self-paced condition, with major emphasis on two variables: (1) trials to criterion and (2) time to criterion.

Hypotheses. The following specific hypotheses were tested:

1. Since the self-paced condition allows each S to determine when he will respond (so that his progress may be slower in the early trials, for example, and faster later on) the Ss in this study should attain criterion performance in fewer trials than comparable Ss in Study II.

2. Time to criterion should be facilitated in the self-paced condition, although the difference between pacing and self-pacing should not be as large in time as in trials to criterion.

3. In addition, the hypotheses of Study II were retested.

Materials: A black circle rather than a red cross, and a black cross rather than a green cross distinguish the task stimuli of this study from those of Studies I and II. These changes facilitated filming for the teaching machine and also eliminated the difficulty encountered by color-blind *Ss*.

Subjects: Sixty college students from a University of Illinois introductory psychology class in which participation in the study was a class requirement. No more than five *Ss* were run at a time, one to each machine. The *Ss* were assigned to one of six experimental groups in this study: three groups were replications of the no-information and full-information (both algebraic and geometric) groups of Study II; the fourth group, also a full-information group, is comparable to the column group in Study IV; the fifth and sixth groups were cue and principle groups for whom the information was given in terms of the column group's model.

Procedure: Stimuli were presented on film via a teaching machine. Only one stimulus frame was seen at a time by the subject; the correct answer for each frame was given on the following frame. The *S* could return to the immediately-prior frame to investigate any discrepancy between his answer and the correct answer. The presentation of stimuli, therefore, was equivalent to a straight linear program. Correction procedure was not used.

Findings: The following conclusions about the hypotheses were drawn:

1. The superiority of cue information over principle information again was demonstrated.

2. If there was a difference between paced and self-paced conditions, it was slight. The difference appeared to be in favor of the self-paced condition and apparently was related to the opportunity to re-read complex frames during the task. Time data for each frame would be useful additional information to acquire.

3. The column-model appeared to be a simpler frame of reference for encoding than either the algebraic or geometric models used in Study I. That is, the Ss given information in terms of this model used the information as given and did not manifest the transformations of information to the simpler terms as was observed in Study I.

Some Perceptual and Verbal Factors in the Transfer From One Task to Another Generated From the Same Model

Reference: Stolurow, L. M. and McHale, T. J.

Status: Completed.

Type of Study: Experimental.

Problem: When the verbalized rules of the solvers in Study II were examined, seven categories were established. These verbalizations ranged from general and abstract to specific and concrete. If different rules are verbalized, meaning that the Ss have learned different "concepts" (intraverbal behavior), even though their overt behavior is the same, then differences in transfer to a second task should occur. This study was designed to discover whether this is a useful conception. It related the statements made by the Ss at the end of Task 1 to their performance on Task 2.

Hypotheses. The following specific hypotheses were tested:

1. The rank-order predictions of the subjects' relative rates of learning to solve Task 2 can be made from a comparison of the verbalized rules used by the Ss in Task 1 with the rule they must learn to solve Task 2.

2. Perceptual similarity of the cues in each task leads to faster solution of Task 2 than perceptual dissimilarity of the cues.

Problem(cont'd.) 3. When the stimuli of two tasks are not obviously similar, and the Ss do not suspect that the two tasks are related, the group told that the two are related should learn Task 2 more rapidly than the group not given this instruction.

4. When two tasks are perceptually dissimilar, the predicted transfer effects should occur only among those Ss who consciously relate the two tasks. The behavior of Ss who consciously do not relate the two tasks should not be distinguishable from that of the Ss in the control group.

Materials: A small black circle and a small black square on 3 x 5 cards. For the transfer task, 3 x 5 stimulus cards on which there was a circle, square, triangle and rhombus. One of four numbers (1, 2, 3 or 4) was presented within each geometrical figure.

Subjects: Five Ss were run in each cell for a total of 60 Ss. There were four groups, one for each of four sets of instructions or rules, with 15 Ss in each group. A control group of 20 Ss was also run, half of which solved Task 2 with one of the formulae (A or B) and half with the other. The control group was allowed to warm up on a neutral memory task before working on Task 2A or 2B.

Procedure: Task stimuli. The training task in this experiment was essentially the same as the task used in Studies I, II and III. There were two minor changes:

1. As in Study III, a small black circle and a small black square replaced the red cross and green cross used in Studies I and II.

2. The stimuli were presented to Ss on individual cards. The transfer task used 3 x 5 stimulus cards on which there was a circle, square, triangle, and rhombus. One of the following four numerals was printed within each geometrical figure: 1, 2, 3, or 4. The numerals within the figures replaced the four discrete coordinate values that the circle and square could assume in the training task. As in the training task, only two of the four figures were relevant. The correct rule to obtain k (criterion response) was the sum of two products obtained by weighting the values in two of the figures. Either one of the following alternatives, both involving a two and one weighting, would work: (a) 2 (number in the circle) + 1 (number in the square), or (b) 2 (number in the triangle) + 1 (number in the rhombus).

Four tasks, two training and two transfer, actually were used, designated 1A, 1B, 2A, and 2B. The Arabic numeral represents the stimulus encoding: 1 stands for the displays with the circle and square that varied

Procedure: **(cont'd.)** their positions in a field; and 2 stands for the displays with the circle, square, triangle and rhombus containing numerals from 1 to 4. The letters stand for the weighting principle required to secure the correct k values. In each case, the change from A to B signifies a reversal shift.

Presentation of stimuli. Four sets of instructions or rules were presented to four groups of Ss: (1) full-information [k = 2 (row of the circle) + 1 (row of the square)]; (2) full-information column [k = 2 (column of the circle) + 1 (column of the square)]; (3) full-information algebraic; and (4) a solution in which the 2:1 weighting was only implicit. These sets of instructions were suggested by the verbalizations of the subjects in Study II; in this sense, the instructions given were second generation solutions to the problem.

Within each group of Ss (N = 15 for each group) there were three types of transfer treatments which were differentiated by (1) correct formula and (2) knowledge of the relatedness of the two tasks. The three treatments were (1) the correct formula: 2 (number in circle) + 1 (number in square), (2) the correct formula, and (3) a hint that the training and transfer tasks were related. This generated a 4 x 3 factorial design with both factors fixed.

Procedure: (cont'd.)

After the S read one of the sets of instructions, the E presented the stimulus frames for Task 1A one at a time. The S gave his numerical response for the value of k, and also the rule he was using on each trial. This procedure was repeated in Task 1B, in which the only difference was the formula used to assign weights. This made Task 1B a reversal shift of Task 1A. The S was not informed that a switch was being made, nor was he allowed to ask questions at the time. This switching of rules was included to investigate the transfer effects of a first reversal shift to a second one. After solving the first task (1A) and its shift (1B), the subject was read the instructions for Task 2A and began it immediately. After reaching criterion on 2A, the formula was again changed and S began Task 2B, a reversal shift of Task 2A. Post-experimental interviews were conducted after each task.

Findings:

The following conclusions can be made:

1. Hypotheses 1, 3, and 4 were confirmed.
2. A conclusion as to hypothesis 2 is not clear. It seems that the perceptual similarity of cues facilitates transfer performance if the verbalized principles of solution are similar for the two tasks. If the cues are perceptually similar and the verbalized principles of solution are not the same for the two tasks, there is no noticeable effect on transfer.

Findings(cont'd.)Thus, the form of the intraverbal behavior seems critical. The way in which the stimulus display is encoded by the learner can be an important factor in determining the degree of transfer of training which results.

How Conscious is Transfer of a Specific Rule?

Reference: McHale, T. J. How Conscious is Transfer of a Specific Rule? Urbana, Ill.: University of Illinois, Training Research Laboratory, U. S. Office of Education Contract 4-20-002, Tech. Rep. No. 6, August, 1965.[1]

Status: Completed.

Type of Study: Experimental.

Problem: Two problems were encountered in Study IV: (1) the need for concurrent measures of transfer (which indicate an awareness that transfer is occuring) rather than after-the-fact measures of transfer (indicating that the task is solved) and (2) the difficulty of handling negative transfer when intratask hints are given because of the systematic elimination of negative elements by these hints. A larger experiment was conducted, therefore, in which the Ss were encouraged to "think aloud". The experiment was so designed that transfer, if it occurred, would be positive.

Hypotheses. The following specific hypotheses were tested:

1. When the stimuli of two tasks are not obviously similar (perceptually dissimilar), and Ss may not suspect

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[1] Based on McHale, 1965.

Problem(cont'd): that the two tasks are related, instructions stating that the two are related should facilitate the speed of solving Task 2.

2. The type of solution-rule in the transfer task will be related to the type of solution-rule in the training task.

3. When two tasks are perceptually dissimilar, and no hint of their relationship is given, the predicted transfer effects should occur only among those Ss who consciously relate the two tasks. The performance of the Ss, who consciously do not relate the two tasks, should be indistinguishable from the performance of the Ss in the control group in (a) trials to criterion, (b) type of solution discovered, and (c) the process by which solution is attained.

Materials: Two sets of materials were used, one for the training task and one for the transfer task. Materials for the training task consisted of a square containing a circle and a square located at the intersection of the lines identifying the four columns and four rows of the display. The circle and the square could appear in any row and any column. The rows and columns are numbered from 1 to 4 from bottom to top and left to right, respectively. Hash marks on the frame were

Materials(cont'd): included. In the model used to determine correctness, the column values of both the circle and square were relevant but the row values were irrelevant.

In the transfer task, a circle, square, triangle and rhombus appeared on each stimulus card and either a 1, 2, 3 or 4 appeared inside each figure. Any number could appear in any figure. Each figure appeared in any one of four positions counting from left to right. Either the numbers within the figures or the positions of the figures could replace the row and column figures of a training task. The position of the circle and square are relevant and the numbers within the triangle and rhombus are irrelevant. The three rules used were:

(1) 2 (position of the circle) + 1 (position of the square);

(2) 3 (position of the circle) + or - the number of the positions from the circle to the square --
+, if the circle is to the left of the square,
-, if the circle is to the right of the square;

(3) 2 (number in the triangle) + 1 (number in the rhombus).

Subjects: There were 28 Ss in each condition without knowledge of the relatedness of the two tasks, and 20 Ss in each condition with such knowledge for a total of 96 Ss. There was an equal number of males and females in all conditions. A control group of 32 Ss also was included.

Procedure: Task stimuli. The training task was identical to that used in Study IV. The following modifications of the stimuli for the transfer task were made:

1. The task was so designed that any S could discover any of three solutions.

2. Pilot work indicated that positions were used infrequently if position numbers were not included below the figures, so these numbers were added.

Presentation of stimuli. The two sets of instructions for Task 1 were (1) full information in terms of column (identical to that in Study IV), and (2) a solution in which the 2:1 weighting was not explicit:

> 3 (column of the circle) ± the number of columns from the circle to the square (+, if the circle is to the left of the square; -, if the circle is to the right of the square).

This latter set of instructions is similar to set four in Study IV. After the S read one of the two sets of instructions, he answered a set of questions designed to assess whether he understood the instructions. If S gave evidence of misunderstanding, E attempted to clarify the instructions. The stimuli for Task 1 were presented singly. The S gave his numerical response and the rule he was using on each trial in both tasks. He was encouraged to "think aloud" during both tasks. Since the purpose of the first task

Procedure(cont'd): was to teach S a rule, E attempted to explain what S was doing wrong if he made mistakes during the task.

After solving the first task, the S was read the instructions for Task 2 and began it immediately. The transfer task conditions were differentiated by knowledge of the relatedness of the two tasks. The transfer task was so designed that any of the three following formulas would generate the criterion responses: (1) 2 (position of the circle) + 1 (position of the square); (2) 3 (position of the circle) ± the number of positions from the circle to the square; and (3) 2 (number in the triangle) + 1 (number in the rhombus).

The controls were divided into two equal groups. One of these was given "easy" items of the Raven's Progressive Matrices test (1956). The other was given "difficult" items to produce a set in S for an easy or a difficult task. The experimental Ss, who were given pretraining rule 2, were assumed to have a more difficult Task 1 condition than those who were given pretraining rule 1. Consequently, two different controls seemed indicated. Subtests A, B, and C of the Raven's test were used to create the "easy" warm-up task and subtest D and E were used to create the "difficult" warm-up task. A post-experimental interview was conducted after Task 2 with all Ss.

Findings: The results of the transfer task were analyzed in terms of three dependent variables: (1) trials to criterion, (2) type of solution verbalized, and (3) various measures of the learning process. On the basis of both spontaneous verbalizations during the task and answers to questions during a post-experimental interview, Ss were categorized into those with or without transfer hypotheses and transfer intentions. The following tentative conclusions can be made:

1. With trials to criterion as the dependent variable: (a) only knowledge of the relatedness of the two tasks was a significant variable; (b) neither type of pretraining rule nor (c) sex made a significant difference.

2. Type of solution verbalized made a difference both in the type of solution discovered and in the process of solution for the second task.

3. When Ss, who did not report a transfer intention, are compared with control Ss, the following additional results are indicated by various measures of the learning process: (a) though conscious (verbalized) relating of the two tasks accounts for the bulk of positive transfer, data indicate that a small amount of unconscious transfer (not verbalized) did occur; (b) four of the former solved the transfer task without any task hints, none of the controls

Findings(cont'd): did; and (c) there seemed to be more guessing (offering no formula), less use of two cues, and less use of position cues among the controls.

INDIVIDUAL DIFFERENCES IN ENTERING BEHAVIOR

The two studies summarized in this chapter are concerned with the development of individualized remediational materials for individuals with specific learning disabilities in reading. The disabilities, identified by the Illinois Test of Psycholinguistic Abilities (see Appendix A) were particularly apparent for decoding association and encoding. It was these processes for which a self-instructional format was developed for use on an electric typewriter.

The format progressively moves the student from a stage of sheer copying procedure to one in which full lines of type are reproduced from memory. In the process the material forces the student to engage in decoding association and encoding. Variations and conditions used in practicing will be investigated to determine whether they influenced the mediational processes in differential ways.

Development of Encoding and Decoding Skills
Study I

Reference: Stolurow, L. M. and Hernandez, Anita Maria

Status: Completed.

Type of Study: Experimental.

Problem: A pilot study to determine the effectiveness and feasibility of individualized remediation procedures for learning disabilities and obtain data regarding the methods that might be employed with reading problems.

Materials: Diagnostic tests. Diagnostic tests included the Hegge, Kirk and Kirk Remedial Reading Drills, the Harvard University Auditory Test, the Gray Oral Reading Test, and the Illinois Test of Psycholinguistic Abilities (see Appendix A).

Aptitude tests. Aptitude tests included the Stanford Achievement Test, Primary Battery, Form J; the Stanford-Binet Intelligence Scale, Form L-M; and the SRA Primary Mental Abilities Test. (see Appendix B).

Special materials. These materials utilized the words in the Hegge, Kirk and Kirk drills as a means of giving students selective practice in decoding and encoding skills. A special format generated by SOCRATES according to a set of rules was prepared for use in this study. The materials

Materials: (cont'd.) were generated through the use of the AUTHOR[1] I program. The particular phonetic elements for which words were selected and drills prepared were determined by the diagnostic tests and the phonetic deficiencies common to the students who were subjects. Each set of materials consisted of a page of four rows of four words each. Three sounds (short a, short o and oo) with three rules for each sound and four sets for each rule were presented. For Rule 1 the terminal sound was held constant (e.g., SAT, MAT, RAT, BAT). Rule 2 held the initial letter constant for one pair of words and changed it to another letter for a different pair, varying the final letter throughout. Or Rule 3 paired the final letters, varying the initial letter throughout (e.g., HAM, MAN, HAT, MAD or LOOM, MOOD, BOOM, FOOD). A set of training materials consisted of four rows of cue words, four rows of blanks to be completed by the subject and four rows of "feedback" words to provide knowledge of results, making four groups of cue words, blanks and reinforcement words. The cue words were faded one letter at a time so that the final row of cue words consisted only of asterisks. See Table 1.

Apparatus. An electric typewriter with automatic carriage return was used, as was a tape recorder.

Subjects: A total of 10 second and fourth grade children (nine second graders and one fourth grader) between 6 - 7 and 9 - 9 years of age were used. Mental ages ranged from 6 - 6 to 8 -11

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[1] AUtomatically Translating Heuristically Organized Routines.

Subjects: (cont'd.) (IQ between 88 and 119). Subjects were split into two groups of five children each, a Say-Type (S-T) group and a Type-Say (T-S) group. All children had encoding problems determined on the basis of the ITPA[2] and teacher reports. They were selected from four Illinois schools: Thomas Paine, Hayes and Washington Elementary Schools in Urbana and Gregory Elementary School in Champaign.

Procedure: Two groups, S-T and T-S[3], were treated individually for 30 minutes each day, four days a week, over a period of 30 days.

Touch-typing training. Ten minutes of each session during the first three days was given to the teaching of touch typing. The children were instructed on the "home" keys for the individual figures, starting with the index finger on the right hand proceeding outward to the little finger, then to the left-hand index finger, etc. The same order was used for locating the upper and lower keys for each finger, right-hand index finger to little finger; left-hand index finger to little finger. When the students were well established on the home keys, they were trained to shift each finger separately from the home key to an upper or lower key and back again. The keys were covered with colored

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[2] The test was administered in 1963.

[3] S-T and T-S initials distinguish between those students who first said and then typed the word and those who first typed and then said the word.

Procedure: (cont'd.)

tape after the first two days of treatment. Pretraining involved instruction on the letters, space bar, tab, tab clear and tab set. Numerals and punctuation marks were not included in the training as well as keys for the setting of margins and other functions of the typewriter. The student set the tabs of the typewriter and, having read each word, typed it in the space provided on the line below. He did this for each of the four words on each line and, upon finishing a row, rolled the platen and exposed the confirmation words which enabled him to compare his responses with those required. The tab key was used by the student to proceed from word to word along the row. Criterion for the entire set was the completion without error of the final row. When this had been accomplished, he went on to the next set.

Vocal recording. All vocalizations of the subject were recorded and played back to the child after he had completed each set.

Scoring. The treatment material was scored for each child for: number of responses made, each typed stroke being one response; rate of response -- number of responses per set divided by the time required to complete that set; number of sets completed without regard to criterion; number of sets completed at the level of criterion; and errors. Errors were broken down into verbal errors, memory errors,

Procedure: (cont'd.) transpositional errors, and typing errors. The transpositional errors were further reduced to "word" or "letter" errors for these two categories. Verbal errors were mispronounched words. An error was considered to be a memory error when the child failed to type a response to a vanished cue. In some cases he would type part of the word, leaving the vanished letter out. This was designated as a letter, memory error. In other cases the whole word was omitted. This was designated a word, memory error. If the child typed the letters of a word in the wrong sequence (ART instead of RAT), letter, transpositional errors were scored. If he typed the words correctly but in the wrong sequence, word, transpositional errors resulted. An error was scored for each letter or word out of sequence. In the above example ART would be counted as two transpositional letter errors. This was considered necessary since transpositional errors, particularly of the word type, did not always occur in pairs, one transpositional error occurring with one or more memory errors, or three transpositional errors occurring together. Typing errors were scored for each letter typed that did not appear in the cue word, each space between letters of a word, and each letter in excess of the three or four indicated by the cue word. These scoring variables are being combined into various ratios and will be considered as dependent variables. Correlation matrices are being computed, comparing

Procedure: (cont'd.) these dependent variables with the independent variables of the pretreatment and posttreatment tests, including adjusted mental ages. Results will be given in a subsequent report.

Findings: *Encoding*. Pretreatment and posttreatment scores on the vocal and motor encoding sections of the ITPA were compared with a resulting t of 2.87, $df = 9$, $.01 < .005$, for the vocal subtest and a t of 1.58, $df = 9$, $.10 < p < .05$, for the motor subtest.

S-T and T-S groups. See Figs. 1-10 for the mean response rates for each of the 10 children in the S-T and T-S groups. In comparing the S-T and T-S groups for learning, Fig. 11 indicates superior performance for the S-T group. This difference, however, is not a significant difference as an analysis of variance demonstrates. A two-factor, repeated measures analysis of variance compared the S-T and T-S groups on factor A and the progressive days of performance on factor B. The performance factor was broken down into three blocks of six days each, starting with the second day of treatment. Results indicated a significant practice effect ($F = 8.48$, $df = 2/16$, $p < .001$), but no significant difference between the S-T and T-S groups ($F = 1.12$, $df = 1/8$, $p > .05$). The significant practice effect demonstrates learning as indicated by an increasing typing rate. A t test comparing the S-T and T-S groups on day one showed no significant difference between the two groups to start with as indicated in Fig. 11. ($t = .37$, $df = 3$, $p > .10$).

Table 1

Materials Used in Study I

Order of presentation	Page	Drill	Rule	Set	Words
1	1	1	1	1	SAT, MAT, RAT, BAT
2	2	1	1	2	CAP, SAP, MAP, TAP
3	3	1	1	3	RAM, SAM, HAM, JAM
4	4	1	1	4	RAG, BAG, TAG, WAG
5	1	1	2	1	SAT, SAP, SAM, SAD
6	2	1	2	2	MAP, MAN, MAD, MAT
7	3	1	2	3	TAN, TAP, TAG, TAB
8	4	1	2	4	CAB, CAT, CAP, CAN
9	1	1	3	1	SAT, MAN, FAT, TAN
10	2	1	3	2	MAP, CAN, MAD, CAT
11	3	1	3	3	RAG, CAT, TAG, PAT
12	4	1	3	4	HAM, MAN, HAT, MAD
13	1	2	1	1	HOT, POT, NOT, ROT
14	2	2	1	2	SOB, ROB, MOB, BOB
15	3	2	1	3	HOP, MOP, TOP, POP
16	4	2	1	4	COG, FOG, HOG, JOB
17	1	2	2	1	HOP, HOT, HOG, HOD
18	2	2	2	2	POP, POD, POT, POD
19	3	2	2	3	COB, COG, COD, COT
20	1	10	1	1	BOOT, HOOT, ROOT, TOOT

Page 2 of Table 1

Materials Used in Study I

Order of presentation	Page	Drill	Rule	Set	Words
21	2	10	1	2	BOON, MOON, SOON, NOON
22	3	10	1	3	COOL, FOOL, TOOL, POOL
23	4	10	1	4	BOOT, BOON, BOOM, BOOT
24	1	10	2	1	ROOT, ROOM, ROOD, ROOF
25	2	10	2	2	BOOT, BOON, BOOM, BOOT
26	3	10	2	3	HOOT, HOOF, HOOP, HOOT
27	4	10	2	4	MOOR, MOON, MOOD, MOON
28	1	10	3	1	BOOT, MOON, COOT, NOON
29	2	10	3	2	ROOF, HOOP, WOOF, HOOT
30	3	10	3	3	LOOM, MOOD, BOOM, FOOD
31	4	10	3	4	SOON, TOOL, BOON, COOL

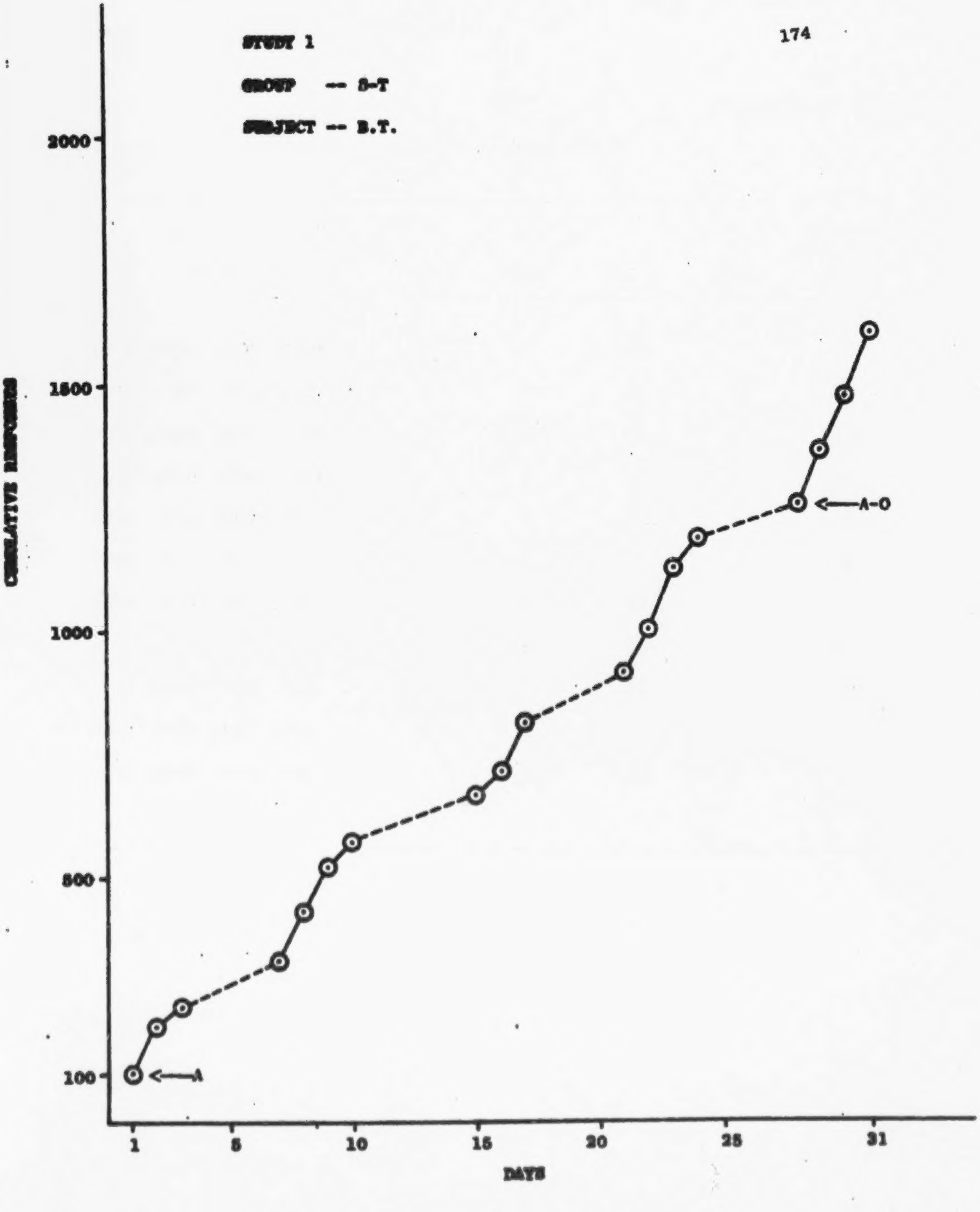

Fig. 1. Mean response rate for B.T. in the S-T group.

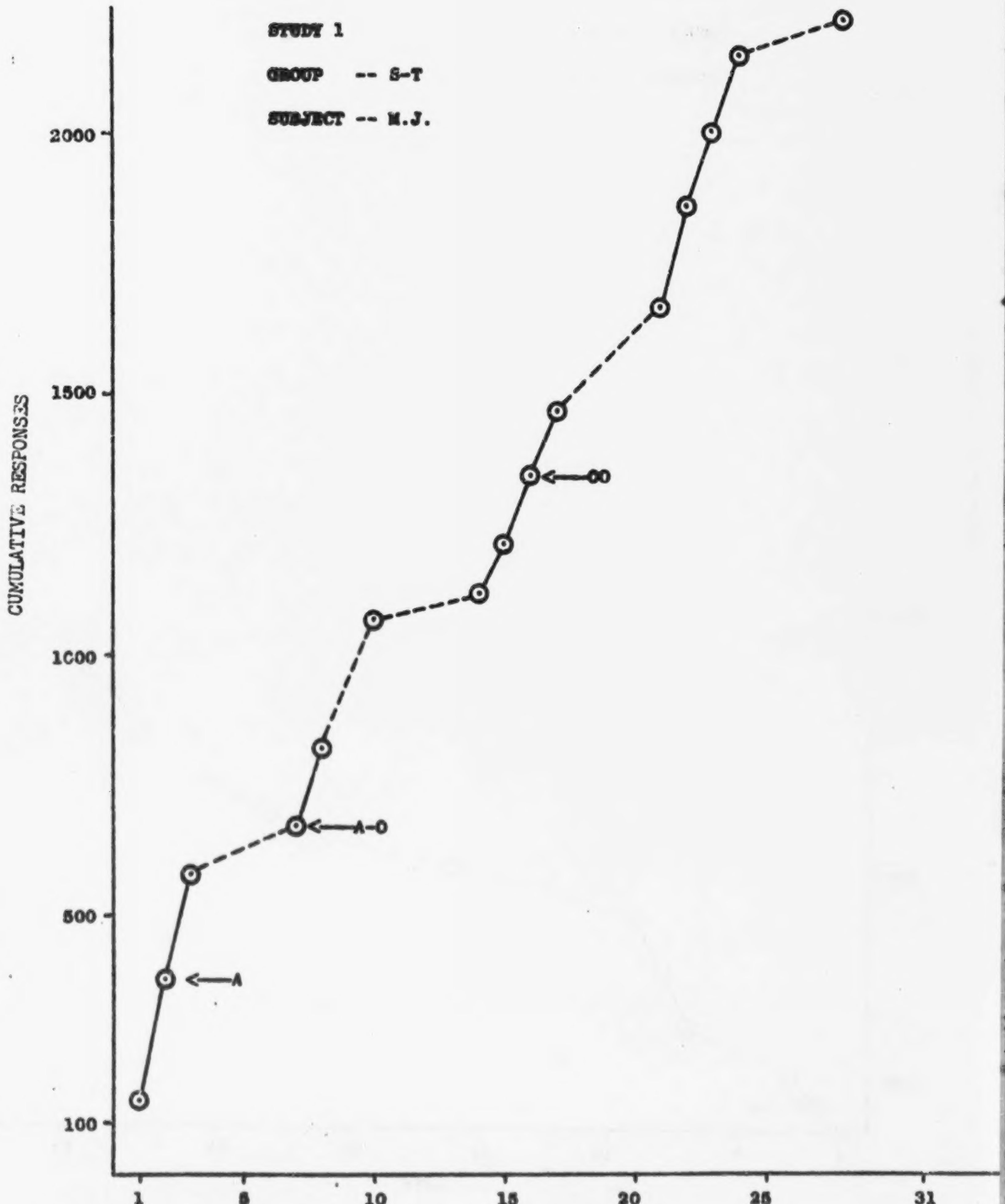

Fig. 2. Mean response rate for M.J. in the S-T group.

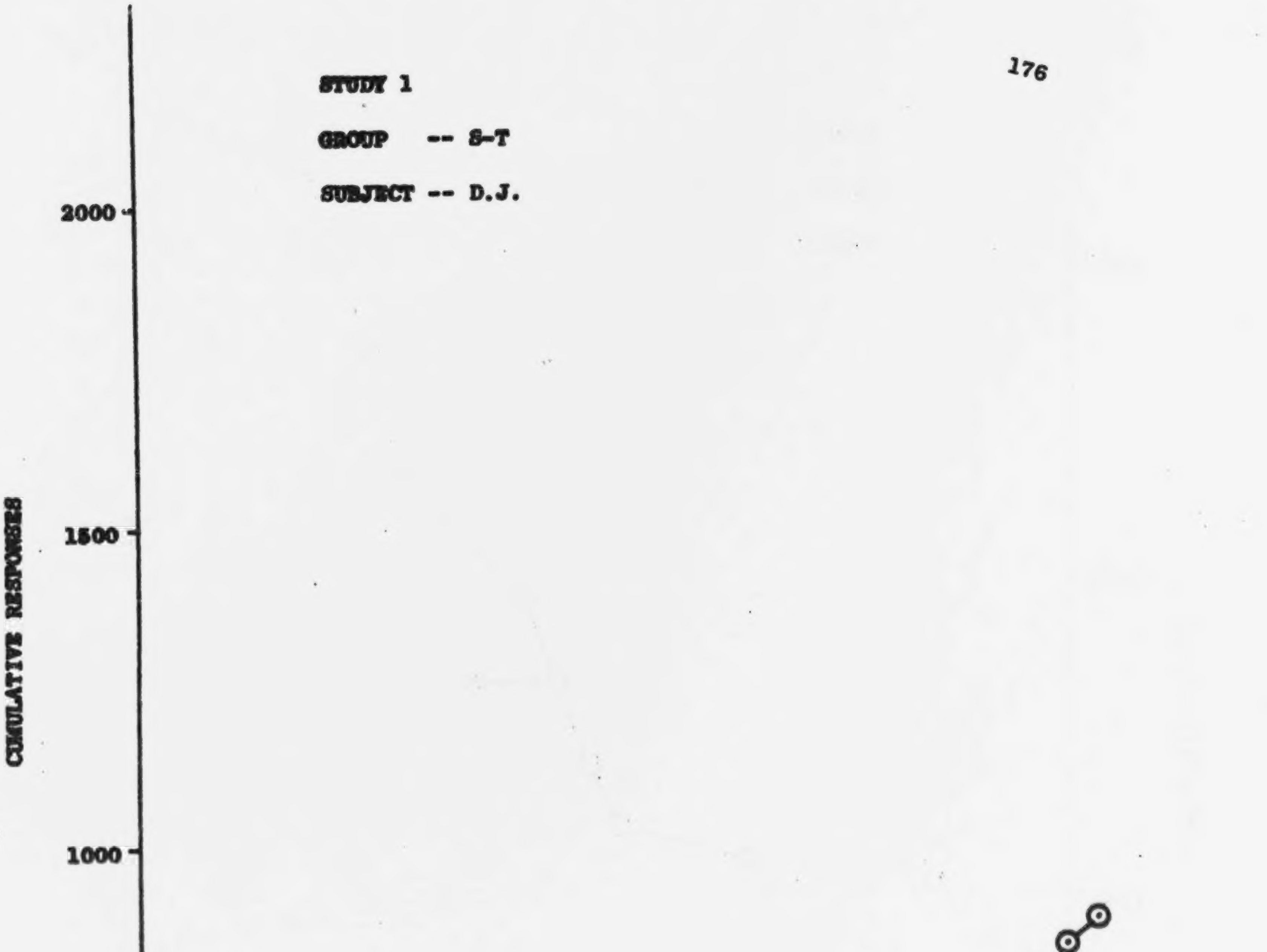

Fig. 3. Mean response rate for D.J. in the S-T group.

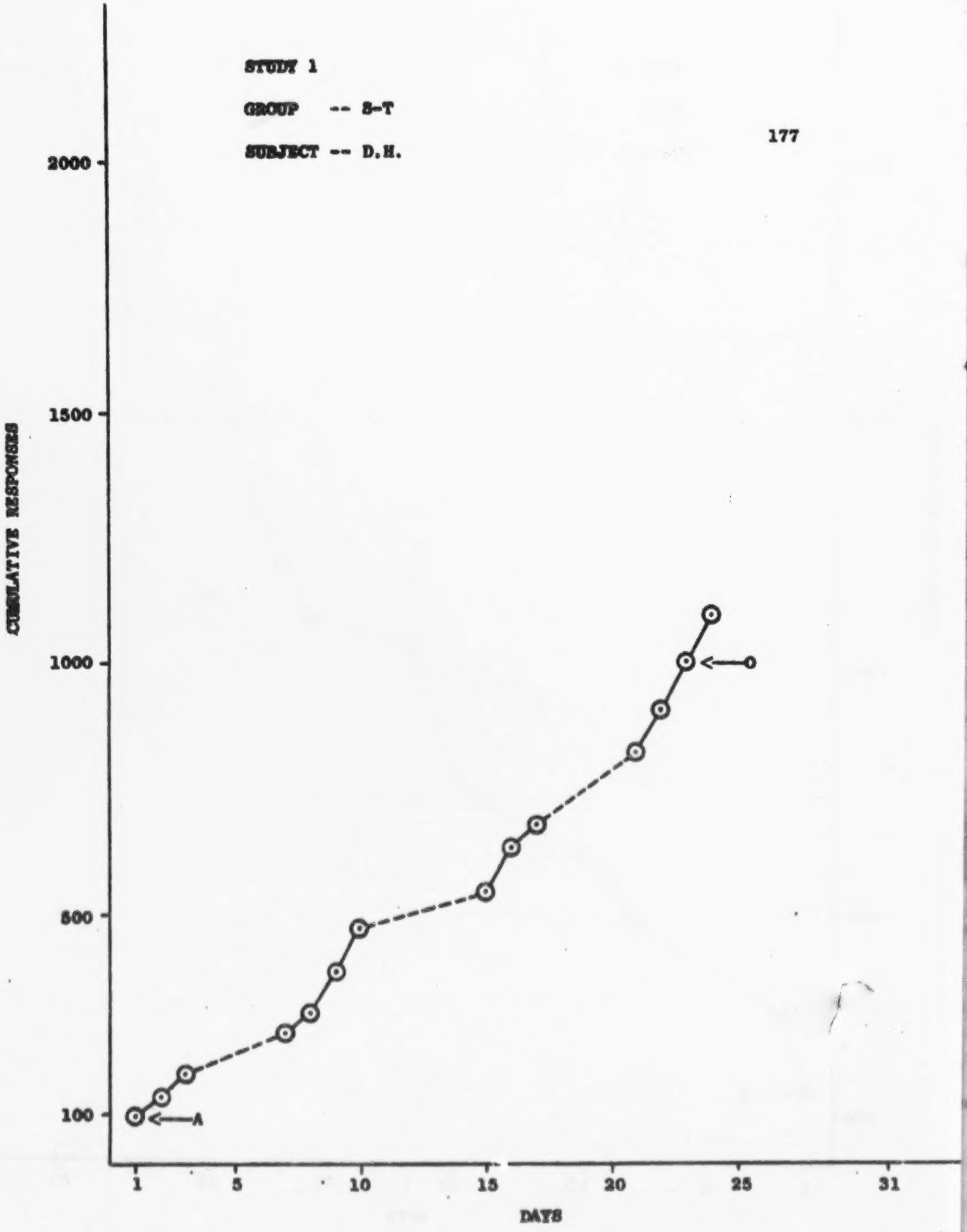

Fig. 4. Mean response rate for D.H. in the S-T group.

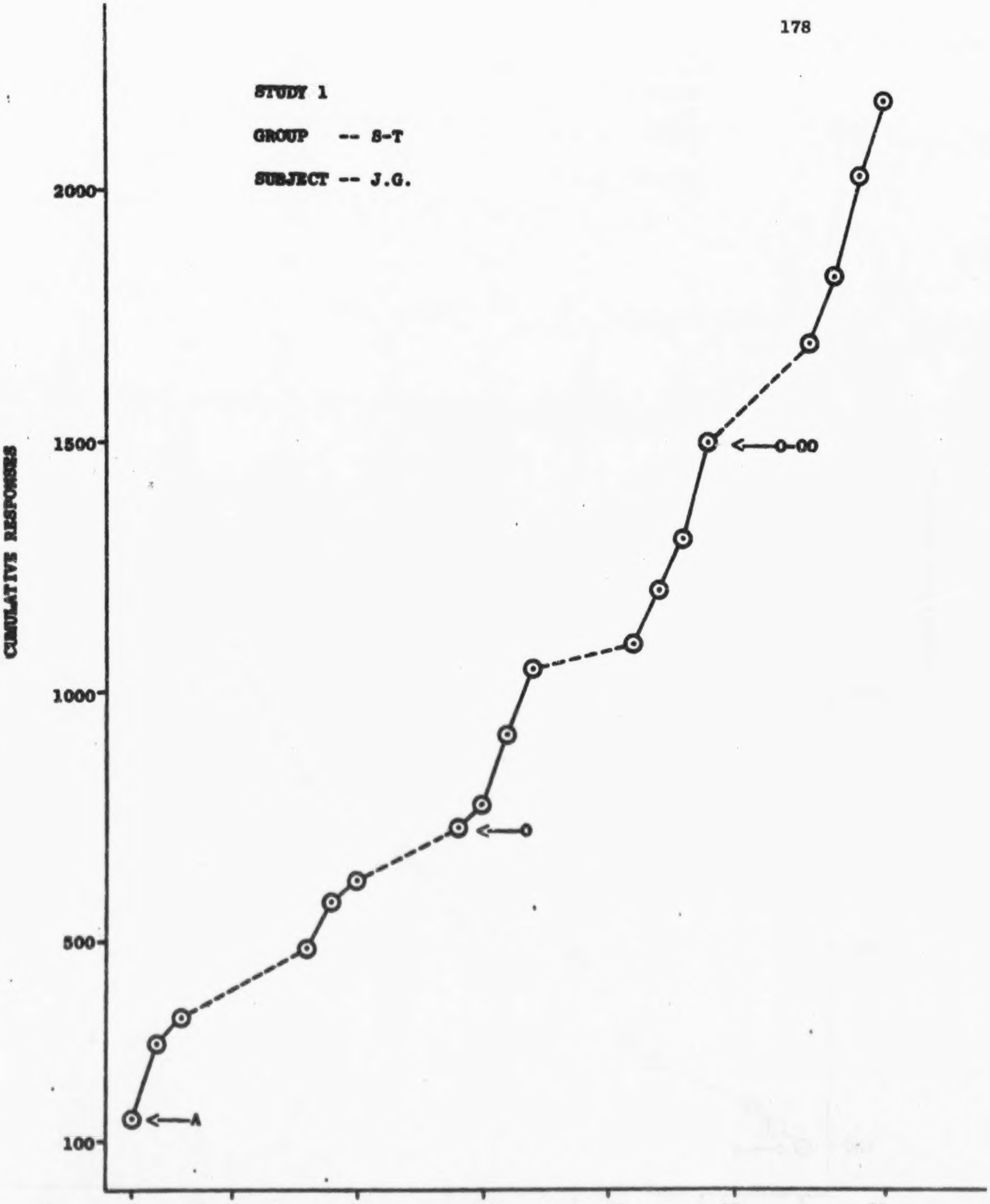

Fig. 5. Mean response rate for J.G. in the S-T group.

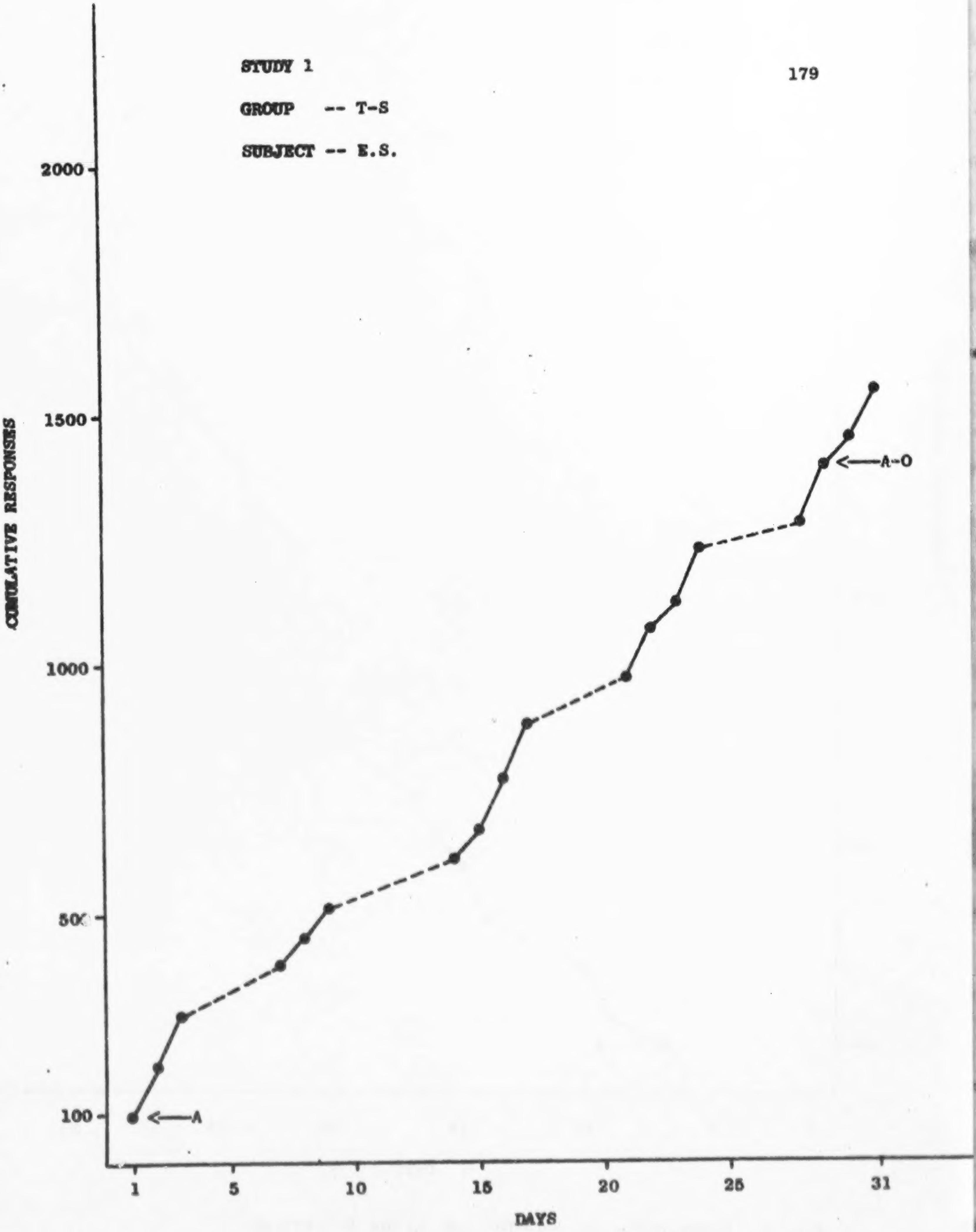

Fig. 6. Mean response rate for E.S. in the T-S group.

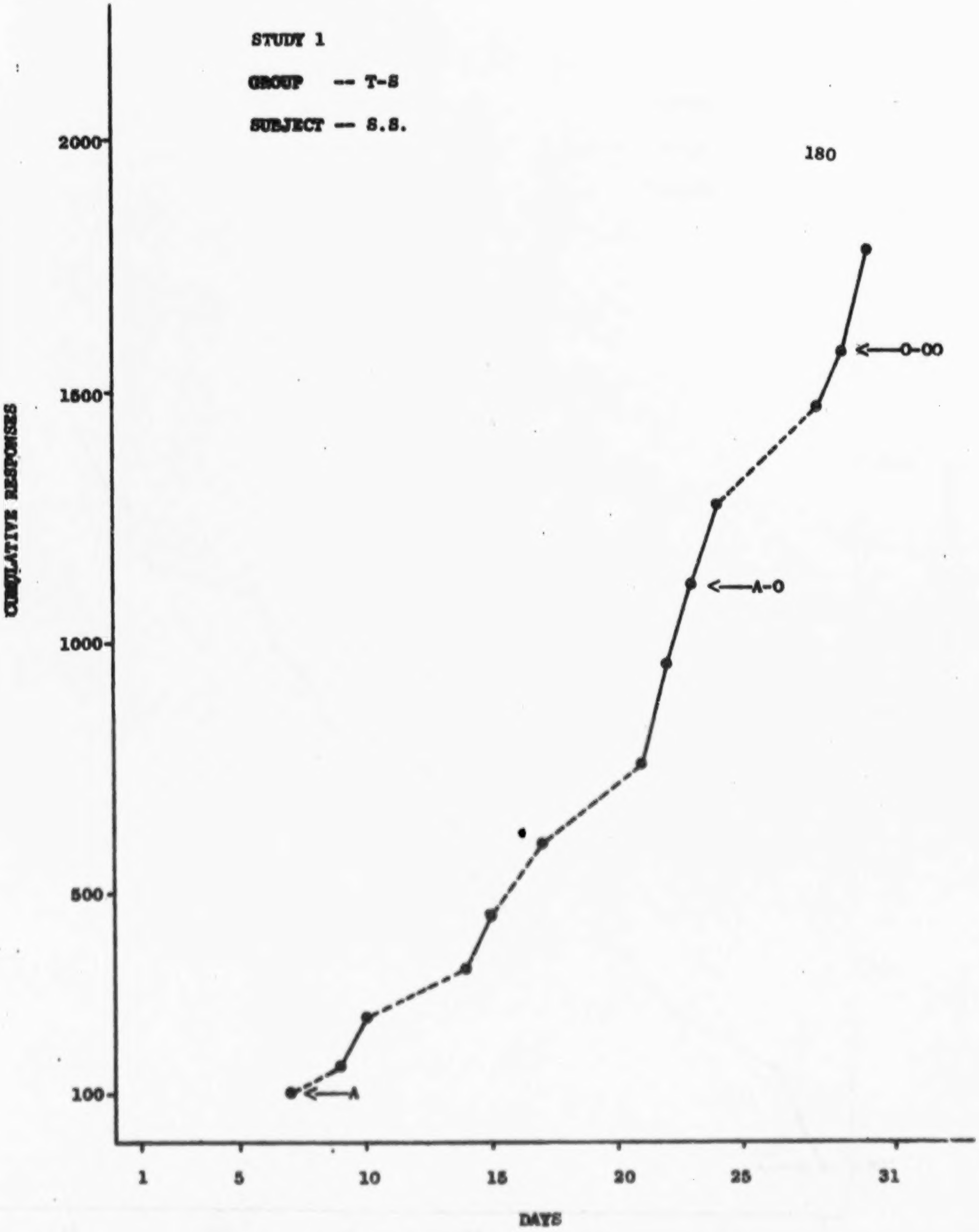

Fig. 7. Mean response rate for S.S. in the T-S group.

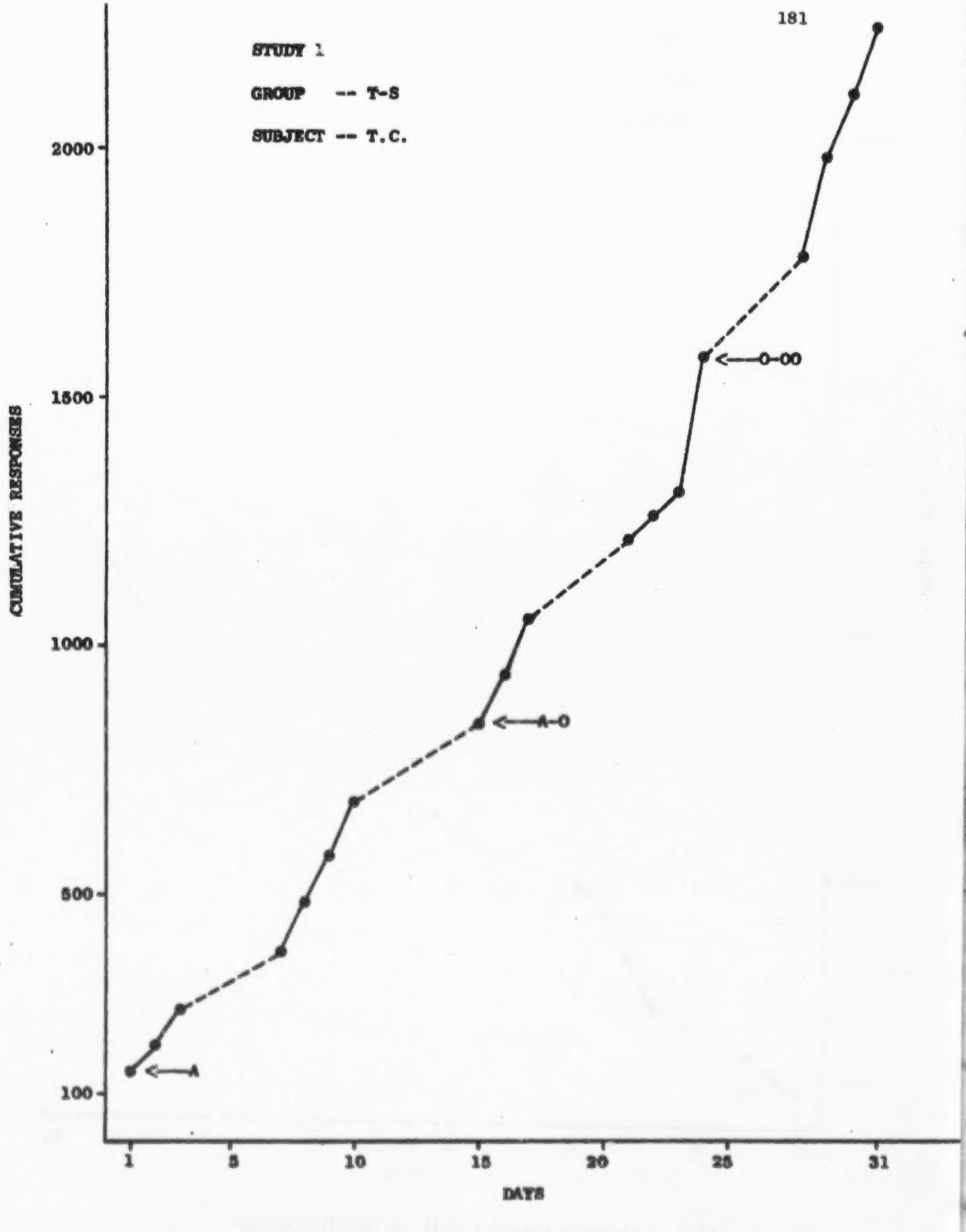

Fig. 8. Mean response rate for T.C. in the T-S group.

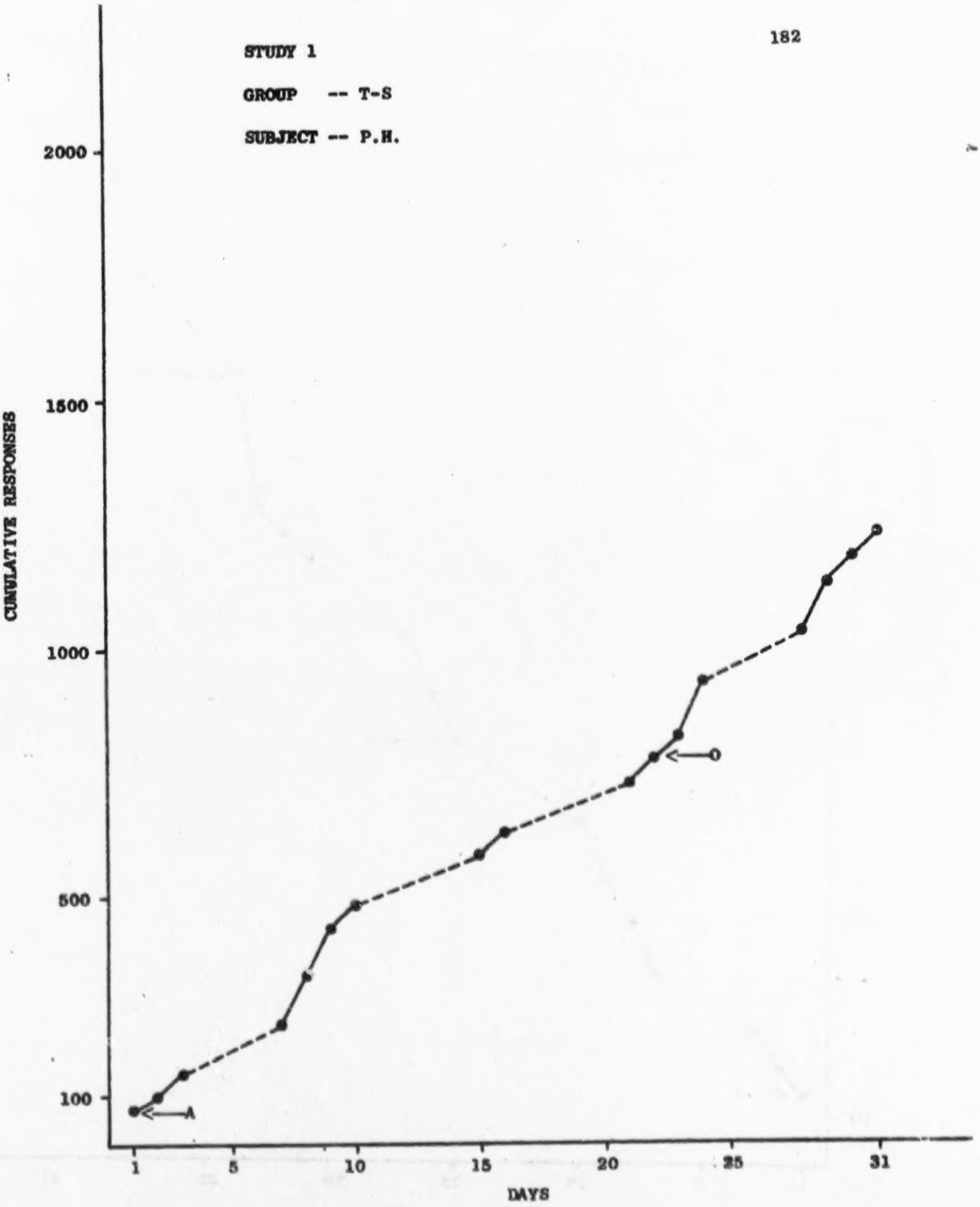

Fig. 9. Mean response rate for P.H. in the T-S group.

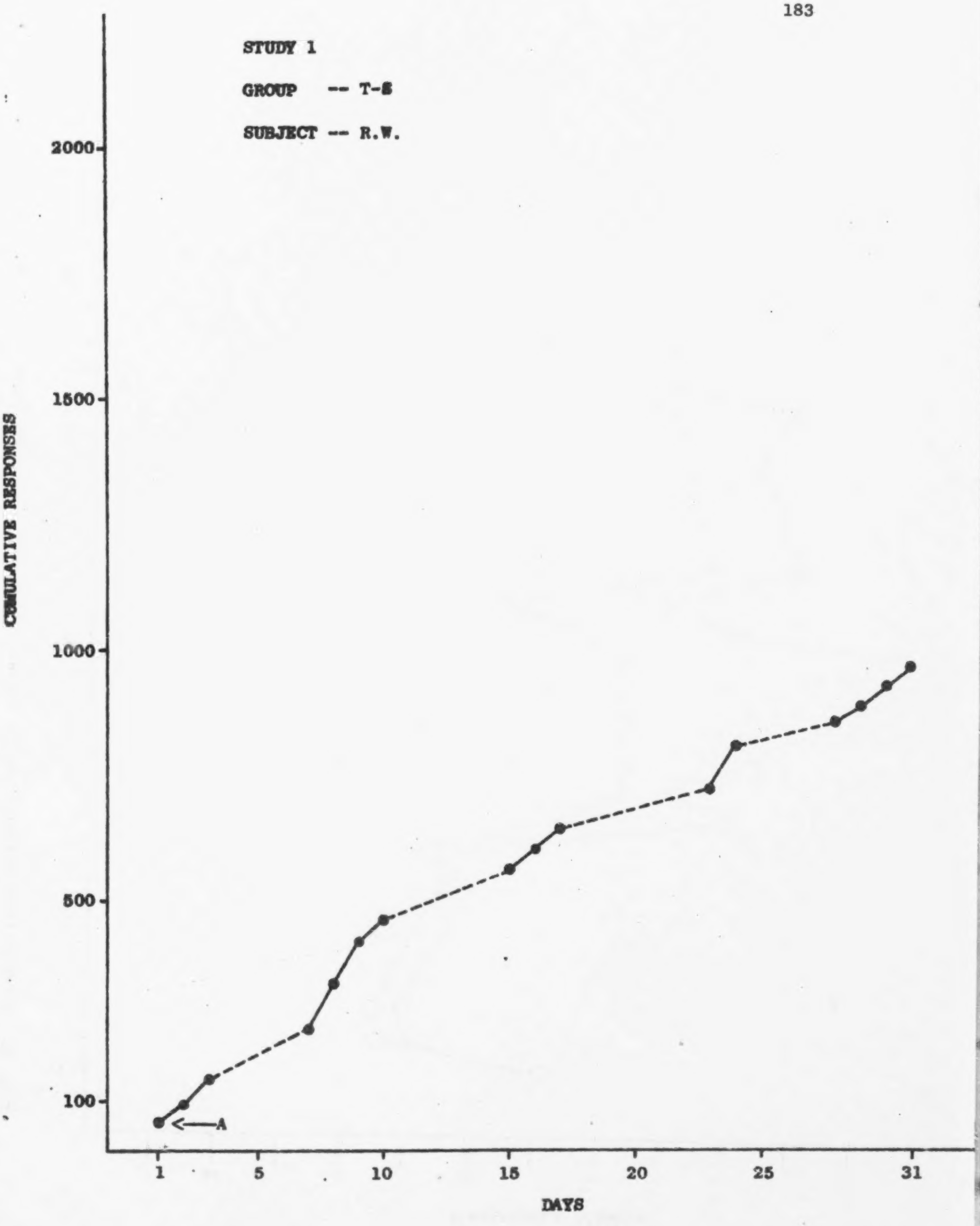

Fig. 10. Mean response rate for R.W. in the T-S group.

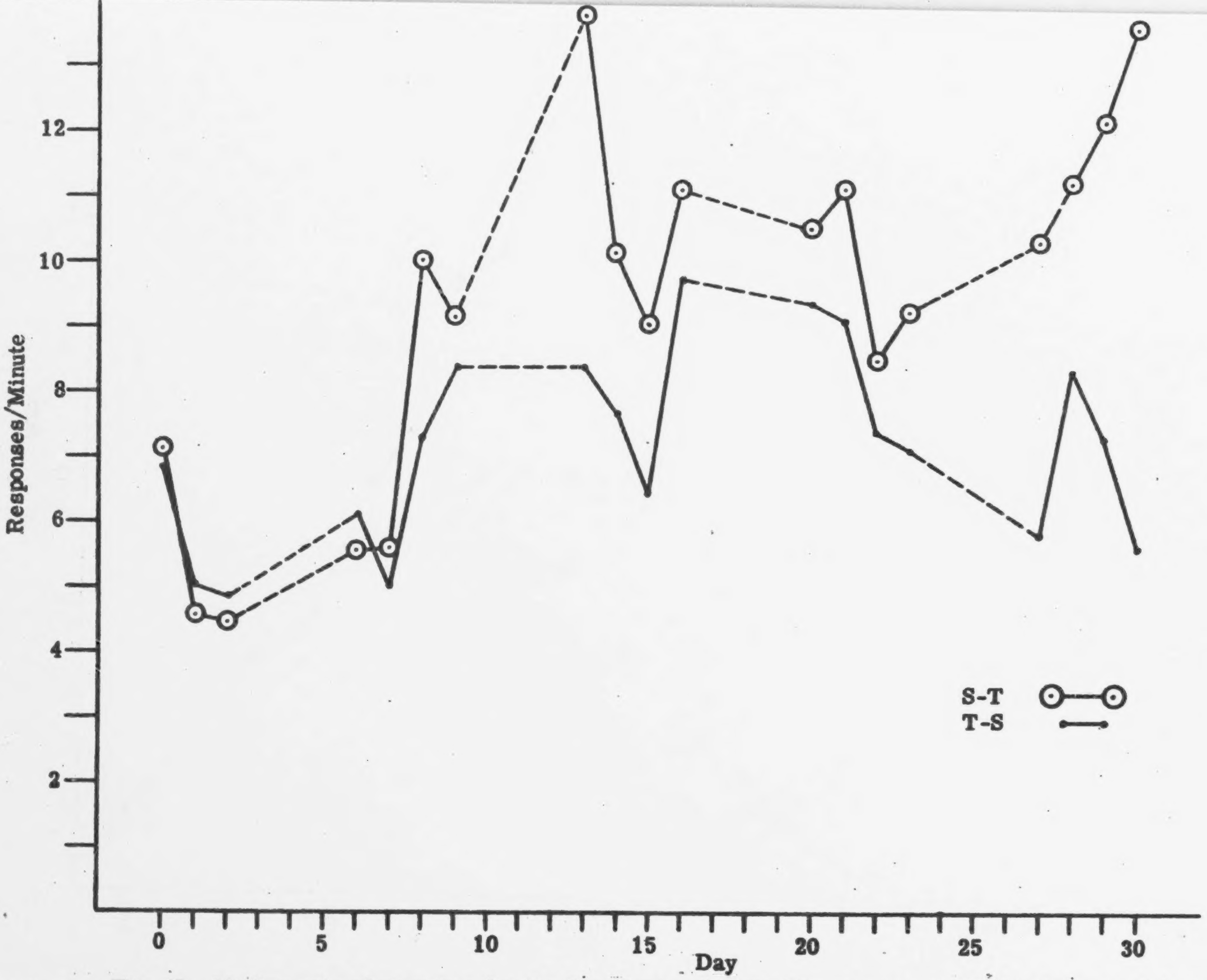

Fig. 11. Median rate of response for the Say-Type and Type-Say groups. Solid line between data points indicates there were no practice sessions missed by the students. Dotted lines indicate that students missed one or more practice periods.

Appendix A

Diagnostic Tests Used in Study I

Gray Oral Reading Test

Gray, W. and Robinson, Helen M., Indianapolis: Bobbs-Merrill Company, 1963.

Harvard University Auditory Test, W-22

St. Louis: Technisonic Audio-Video Studios.

Hegge, Kirk and Kirk Remedial Reading Drills

Hegge, T. G., Kirk, S. A. and Kirk, Winifred, Ann Arbor, Mich: George Wahr, 1940.

Illinois Test of Psycholinguistic Abilities, Examiner's Manual

Urbana, Ill.: University of Illinois Press, 1961.

Appendix B

Aptitude Tests Used in Study I

Stanford Achievement Test, Primary Battery, Form J.

Kelly, T. L., et. al. Chicago: World Book Co., 1952.

Stanford-Binet Intelligence Scale, Manual for the Third Revision Form L-M

Boston: Riverside Press, 1960.

SRA Primary Mental Abilities

Thurstone, L. L. and Thurstone, Thelma Gwinn, Chicago: Science Research Associates, 1948.

Development of Encoding and Decoding Skills
Study II

Reference: Stolurow, L. M., Hernandez, Anita M., Korn, G. and Phillips, Ruby J.

Status: Study in progress.

Type of Study: Experimental.

Problem: Same as in Study I.

Materials: Same as in Study I except that the sounds were a, ar, and the following digraphs: ir, er, and ur. For Rule 1 the terminal sound was held constant (e.g., SIT, FIT, HIT, BIT). For Rule 2 the initial sound was held constant (RIB, RIM, RIP, RIG). Rule 3 held the initial letter constant for one pair of words and changed to another letter for a different pair, varying the final letter throughout. Sometimes Rule 3 paired the final letters, varying the initial letter throughout.

Subjects: Four fifth-grade Negro children with encoding problems, enrolled in Washington Elementary School in Champaign, Ill. Their chronological age ranged from 10-0 to 12-3. Mental age ranged from 9-0 to 12-10.

Procedure: Subjects were divided into two groups, two boys and two girls. Group I was presented the materials as described in the section on materials in Study I. Group II was given the same drills except that the second and third drills were taken in reverse order, the ir-er-ur presentations preceding the ar drills.

Findings: Findings will be presented in a subsequent report.

Table 3

Materials Used in Study II, Girls

Order of presentation	Page	Drill	Rule	Set	Words
1	1	4	1	1	SIT, FIT, HIT, BIT
2	2	4	1	2	HIM, RIM, DIM, JIM
3	3	4	1	3	SIP, RIP, NIP, LIP
4	4	4	1	4	WIN, TIN, SIN, FIN
5	1	4	2	1	HIT, HIM, HID, HIP
6	2	4	2	2	SIN, SIT, SIP, SIX
7	3	4	2	3	RIB, RIM, RIP, RIG
8	4	4	2	4	TIN, TIM, TIP, TIM
9	1	4	3	1	SIP, HIM, FIT, RIM
10	2	4	3	2	SIP, WIN, SIX, WIG
11	3	4	3	3	RID, BIT, HID, HIT
12	4	4	3	4	MID, DIG, MIX, DIP
13	1	13	1	1	DART, HART, MART, PART
14	2	13	1	2	YARD, BARD, HARD, LARD
15	3	13	1	3	LARK, PARK, DARK, HARK
16	4	13	1	4	YARN, BARN, DARN, TARN
17	1	13	2	1	HARK, HARM, HARP, HART
18	2	13	2	2	BARD, BARN, BARK, BARM
19	3	13	2	3	CARD, CART, CARL, CARP

Page 2 of Table 3

Materials Used in Study II, Girls

Order of presentation	Page	Drill	Rule	Set	Words
20	4	13	2	4	MART, MARK, MARL, MARS
21	1	13	3	1	DART, HARM, START, FARM
22	2	13	3	2	CARD, HART, BARD, PART
23	3	13	3	3	DARK, YARD, BARK, LARD
24	4	13	3	4	PARK, BARN, MARK, DARN
25	1	31	1	1	HURL, CURL, BURL, FURL
26	2	31	1	2	MIRK, KIRK, BIRK, DIRK
27	3	31	1	3	FERN, TERN, HERN, KERN
28	4	31	1	4	DIRT, GIRT, GIRL, DIRL
29	1	31	2	1	HERD, HERB, HERN, HERL
30	2	31	2	2	BURN, BURD, BURR, BURL
31	3	31	2	3	GIRL, GIRD, GIRT, GIRN
32	4	31	2	4	PERT, PERL, PERK, PERT
33	1	31	3	1	HURL, BURN, CURL, TURN
34	2	31	3	2	TERN, PERK, KERN, JERK
35	3	31	3	3	DIRK, GIRL, KIRK, DIRL
36	4	31	3	4	FURL, PURR, BURL, BURR

Page 3 of Table 3

Materials Used in Study II, Girls

Order of presentation	Page	Drill	Rule	Set	Words
			Review*		
37	4	4	1	4	WIN, TIN, SIN, FIN
38	4	4	2	4	TIN, TIM, TIP, TIM
39	4	4	3	4	MID, DIG, MIP, DIP
40	4	13	1	4	YARN, BARN, DARN, TARN
41	4	13	2	4	MART, MARK, MARL, MARS
42	4	13	3	4	PARK, BARN, MARK, DARN
43	4	31	1	4	DIRT, GIRT, GIRL, DIRL
44	4	31	2	4	PERT, PERL, PERK, PERT
45	4	31	3	4	FURL, PURR, BURL, BURR

*Beginning with Sequence 37 Set 4 was reviewed using all rules.

Table 2

Materials Used in Study II, Boys

Order of presentation	Page	Drill	Rule	Set	Words
1	1	4	1	1	SIT, FIT, HIT, BIT
2	2	4	1	2	HIM, RIM, DIM, JIM
3	3	4	1	3	SIP, RIP, NIP, LIP
4	4	4	1	4	WIN, TIN, SIN, FIN
5	1	4	2	1	HIT, HIM, HID, HIP
6	2	4	2	2	SIN, SIT, SIP, SIX
7	3	4	2	3	RIB, RIM, RIP, RIG
8	4	4	2	4	TIN, TIM, TIP, TIM
9	1	4	3	1	SIT, HIM, FIT, RIM
10	2	4	3	2	SIP, WIN, SIX, WIG
11	3	4	3	3	RID, BIT, HID, HIT
12	4	4	3	4	MID, DIG, MIX, DIP
13	1	31	4	1	PIRN, SURF, HERL, BURD
14	2	31	4	2	BIRK, SERB, GIRD, HURL
15	3	31	4	3	DIRL, TERN, HURT, SERB
16	4	31	4	4	CURD, BERG, FURL, GIRT
17	1	31	5	1	PERT, CURL, GERM, BIRK
18	2	31	5	2	GIRD, BURN, SERB, HURT
19	3	31	5	3	WERT, KIRK, FERN, HURL

Page 2 of Table 2

Materials Used in Study II, Boys

Order of presentation	Page	Drill	Rule	Set	Words
20	4	31	5	4	TURF, GIRL, HERN, BIRD
21	1	31	6	1	DIRT, CURL, TERN, GERM
22	2	31	6	2	BURP, TURF, HERN, GIRD
23	3	31	6	3	FURN, GIRT, BIRD, SERF
24	4	31	6	4	GIRL, PERT, FURL, BIRK
25	1	13	1	1	CART, DARK, YARN, HARP
26	2	13	1	2	FARM, SCAR, MARS, BARD
27	3	13	1	3	PARD, BARN, LARK, YARD
28	4	13	1	4	HARD, MART, DARN, PARK
29	1	13	2	1	HARP, PART, BARN, SARK
30	2	13	2	2	CARL, HARK, DART, YARD
31	3	13	2	3	BARK, TART, CARD, HARL
32	4	13	2	4	PART, HARD, BARK, GARB
33	1	13	3	1	BARB, NARK, FARL, HART
34	2	13	3	2	FARD, TARN, MARK, CARP
35	3	13	3	3	LARK, BARN, STAR, YARN
36	4	13	3	4	MARL, CARK, HARD, FARM

Page 3 of Table 2

Materials Used in Study II, Boys

Order of presentation	Page	Drill	Rule	Set	Words
			Review*		
37	4	4	1	4	WIN, TIN, SIN, FIN
38	4	4	2	4	TIN, TIM, TIP, TIM
39	4	4	3	4	MID, DIG, MIX, DIP
40	4	31	4	4	CURD, BERG, FURL, GIRT
41	4	31	5	4	TURF, GIRL, HERN, BIRD
42	4	31	6	4	GIRL, PERT, FURL, BIRK
43	4	13	1	4	HARD, MART, DARN, PARK
44	4	13	2	4	PART, HARD, BARK, GARB
45	4	13	3	4	MARL, CARK, HARD, FARM

*Beginning with Sequence 37 Set 4 was reviewed using all rules.

STIMULUS FACTORS IN TRANSFER OF TRAINING

A problem in education that has not been systematically studied is the effect of the encoding, or symbol system, on learning and transfer. The most obvious case of substitute, and presumably equivalent, symbol systems is the natural languages. Second language learning is becoming a topic of interest to researchers, (e.g., Lane, H., 1965) and it is rapidly becoming an area of systematic study. In spite of its ubiquitousness, it is a special case of the general problem. For example, algebra is an alternative language system for geometry; Peano-Russell notation is an alternative for Polish notation in symbolic logic. The following studies attempt to deal with aspects of this general problem.

Learning How to Learn Under Several Cue Conditions

Reference: Mattson, D. E. Learning How to Learn Under Several Cue Conditions. Urbana, Ill.: University of Illinois, Training Research Laboratory, U. S. Office of Education, Contract 2-20-003. Tech. Rep. No. 1, August, 1963.[2]

Status: Completed.

Type of Study: Experimental.

Problem: The objectives of this experiment were (1) to determine the effects of several kinds of training on the subsequent mastery of a modified form of a problem-solving task developed by Azuma (1960) and (2) to evaluate the usefulness of cue-response criterialities in explaining transfer effects.

Hypotheses.

1. Three kinds of transfer effects can be identified and compared: (a) a warm-up effect, (b) a learning-to-learn effect, and (c) an effect associated with cue repetition.

2. Cue repetition is expected to result in a negative effect under a condition in which relevant cues during training become irrelevant during the criterion task (similar to a nonreversal shift). A positive effect is anticipated under a condition in which the same cues are relevant for both training and the criterion task.

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[2] Based on Mattson(1963) Doctoral Dissertaion, University of Illinois; partly published in Mattson, D.E. Three Kinds of Transfer in a Problem-Solving Task. Journal of Educational Psychology. 1965,56, 73-80.

Problem (cont'd.): 3. On the first trial of the transfer task, single-trial criterialities will be higher for cues previously relevant than for cues previously irrelevant.

Materials: Two sets of materials were used. The first were patterned after those used by Azuma (1960). This is designated the "W" waiting task. A task stimulus display in this task consisted of a card with four drawings: a circle, a square, a triangle, a rhombus. Each contained a number varying from 1 to 4, inclusive. Any number could appear in any figure and the figures could appear in any order.

The "X" task contained similar stimulus displays except that the figures either contained or did not contain an "X". The S had to learn to label displays as "K" display or as "O" displays. For each task correct answers for all displays could be determined by using a single rule. The correct rule for the first "X" task, for example, was: any display in which the circle and the square contained "X"'s is a "K" display. All others are "O" displays. For each of the three remaining type "X" tasks, S was required to discuss a similar rule. The three rules for identifying "K" displays were as follows: second "X" task -- the circle and the square both had to be empty. The circle had to

Materials (cont'd.): contain an "X", the square had to be empty. The 4th "X" task -- the circle had to be empty; the square had to contain an "X".

Subjects: The *Ss* for this experiment were undergraduate college students. For the first experiment, in which large group testing procedures were used, the *Ss* participated in the experiment as part of a course requirement. For the second experiment, all *Ss* volunteered to take part.

Procedure: The design of this study was a factorial design involving two degrees of similarity between the training task and the criterion task, and three degrees of similarity between the cues used for the training task and those used for the criterion task. In addition to the six groups (16 *Ss* per group) necessary for this design, an additional group of 16 *Ss* was used as a control group that performed only the criterion task. The entire experiment was duplicated -- once using large group testing procedures and once testing groups of either 7 or 14 at a time.

Findings: The results of the experiment may be summarized as follows:

1. A warm-up effect was identified. *Ss* who performed a series of four tasks quite different from the criterion task, using four cues unlike those used on the criterion

Findings (cont'd.): task, solved the criterion task in fewer trials than Ss in the control group. A learning-to-learn effect was identified. Those Ss, who received training on a series of training tasks which were similar to the criterion task, solved the criterion task in fewer trials than the Ss who received training tasks dissimilar from the criterion task.

2. No transfer effect was found for the similarity of cues between the training tasks and the criterion task. For some Ss, relevant and irrelevant cues remained constant for all tasks; for some Ss, relevant and irrelevant cues were reversed on the criterion task; and for some Ss, completely new cues were introduced during the criterion task. The number of trials needed to solve the criterion task was not affected by any of these three cue conditions.

3. The use of the same two cues in the solution of a number of training tasks resulted in an increased use of these cues on the first trial of the criterion task. The criteriality (correlation) between cues and responses was higher, on the first trial of the criterion task, for cues which previously had been relevant than for cues which previously had been irrelevant.

Relative Transfer Effects of Learning Systems of Notation for Encoding Expressions in a Course of Programed Symbolic Logic

Reference: Stolurow, L. M., Frase, L. T., and Odell, S. J.

Status: Completed.

Type of Study: Experimental.

Problem: The relative merits of teaching alternative notational systems in logic, especially the Peano-Russell (P) and Polish (St. Lesniewski and Lukasiewicz) systems (L), are, unfortunately, unknown. There is no empirical evidence bearing on their relative effectiveness for learning or their use by different individuals. The English-speaking student, required to learn the Polish notation, must overcome competing language habits in order to learn the meaning of "CKApqNpq", for example, since the operators refer to symbols in a sequence quite unlike the English language. The habitual eye-movements are conflicting and this difficulty is compounded by the introduction of a new conceptual system. Some of the ambiguities of parenthetical notation in the Peano-Russell system, however, may be eliminated by the Polish notation. With the Peano-Russell notation, on the other hand, the student who must learn the meaning of "$[(p \vee q) \cdot \sim p] \supset q$" might find the task easier than the alternative Polish expression for two reasons: first, the similarity of the new system

Problem (cont'd): to algebraic notation (especially if he were high in mathematical ability) and second, the similarity between the eye-movements required by the new system and his native language.

In terms of transfer of training, the American student learning to write in one of these notational systems will be learning new responses to old stimuli (sentences and words). These responses either will be similar to previously-learned responses (Peano-Russell notation) or dissimilar (Polish notation). Learning dissimilar responses to old stimuli is typically optimal for negative transfer; hence the first question to be asked is whether one notational system is more difficult to learn initially.

A further question asks whether learning one system first makes it easier to learn the other system. Also, does learning one system lead to greater transfer than learning the other when the criterion of transfer is performance on materials different from those used in the learning task?

Other questions concerning the relationships of the learner's mathematical, verbal, and general reasoning abilities to performance in the two notational systems arise which have import for adaptive, individualized, computer-assisted instruction. For example, would it be more efficient to assign students with high mathematical

Problem (cont'd): ability to one or the other of these notational systems? Does high verbal ability or does high general intelligence indicate which treatment would be the optimum assignment?

Hypotheses: The hypotheses were: (1) Learning scores for two groups, one learning the Polish notation and the other learning Peano-Russell notation, will differ. It should be easier to learn the Peano-Russell notation; (2) When groups that originally learned one notational system must learn the other notational system, transfer scores for the two groups will differ; and (3) A group of ability tests administered to _Ss_ will be related significantly to performance on the logic programs.

Materials: _Pretests._ A pretest covering the material contained in the programed text was given to all students. Ability tests (adapted from the Educational Testing Service, Cognitive Reference Battery, compiled by John French, et al, 1963) covering vocabulary (V-4), inference (Rs-3), mathematical aptitude (R-2), and inductive reasoning (I-1) were given. The latter test is particularly applicable to system _L_ (Polish), since it requires the student to make inferences from combinations of letters. In addition to these tests, college entrance examination scores were available.

The 16 PF, Form A, (developed by W. Cattell at the Institute for Personality and Ability Testing, Champaign, Ill.) personality test was administered to all subjects.

Materials (cont'd): This test provides information on 16 personality factors, including general intelligence, emotionality, and tension.

Logic program. Five books of programed logic covering topics from language to propositional logic in both the Polish and Peano-Russell systems were developed at the Training Research Laboratory.[4] Both sets of five books were designed to parallel each other.

Posttests. After the Ss completed each logic book, they were given an immediate posttest over the material covered in that book. In addition, an overall test was given which parallels the logic pretest. This test was given after all logic books were completed. A transfer test, requiring the S to apply his knowledge of logic to new areas (such as electrical circuits) was given after the logic posttest.

Subjects: Sixty students in an introductory logic course at the University of Illinois and 60 students in a similar course at the University of Buffalo (New York) served as Ss.

Procedure: Since it would be difficult for an instructor to teach both notational systems to different classes during one semester, the New York group studied system L for an entire semester. Their final examination required the use of Polish as well as Peano-Russell notation. The

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[4] Dr. John Kearns, S. J. Odell, and Dr. James Zartman wrote the initial version of this program.

Procedure (cont'd): Illinois group studied P all semester and took the same final examination as the New York group which required each student to transfer to the other notation.

The experiment is designed to yield two types of data: (1) instructional data--characteristics of the logic materials, errors made on each item of the program, time spent on individual frames, test scores, and students' comments on the material— and (2) experimental data—characteristics of transfer of training. Instructional and experimental data will be used both for the elaboration of materials and for the correction of errors and inadequacies in the materials. The experimental design and data to be obtained are summarized in Table 16.

Correlational methods will be used to relate personality and aptitude to performance on the logic program and tests. The difference in performance on learning and transfer tasks (and their associated tests) can provide a measure of transfer. Covariance may be used for comparisons of learning scores and of transfer scores.

Findings: See Tables 16 and 17 and Figs. 4 and 5.

Table 16

Experimental Design of Transfer From Notational System L to System P, and From Notational System P to System L

Measures	Group 1	Group II
Pretest[a]	Given	Given
Learning task	Books 1-5 P	Books 1-5 L
Posttest[b]	Given	Given
Transfer task[c]	Books 1-5 L	Books 1-5 P
Posttest	L and P	P and L

[a] Personality, aptitude and logic tests.

[b] Posttests were administered after each book. A general logic posttest and a transfer test were administered to Ss after they had completed their first program.

[c] Performance judged in terms of study time and errors.

Table 17

Correlations of Abilities with Performance on a Test Covering
Identical Content Taken after Learning the Polish or Peano-Russell Notation
(with Means and Standard Deviations)

Group	N	Inference			Advanced Vocabulary			Letter Sets			Math		
		r	X	SD	r	X	SD	r	X	SD	r	X	SD
Polish	58	.01	15.8	2.8	.09	22.0	5.6	-.01	22.0	4.0	.18	19.7	6.2
Peano-Russell	67	.01	13.9	3.4	.27*	19.5	5.5	.31**	19.8	4.6	.31**	13.5	5.0

*Significant at .05 level (two-tailed test)

**Significant at .01 level (two-tailed test).

Note: Means scores on a posttest (in notation appropriate to groups) were 40.74 (Polish); 49.36 (Peano-Russell); t = 10.2, P < .001.

The following schema reveal the differences between the Peano-Russell and the Polish notations as regards the English sentences and arguments which they symbolize.*

1. Mary is going to the store, and John is a store manager.

P-R** **Polish**

$(p \cdot q)$ Kpq

2. If it is raining, then the streets are wet. It is raining. Therefore, the streets are wet.

$\{[(p \supset q) \cdot p] \supset q\}$ CKCpqp

3. If he is offered $10.000 he will take the job, and if he takes the job he will be offered $10,000.

$[(p \supset q) \cdot (q \supset p)]$ KCpqCqp

4. If Jones expects to gain Browns respect, then, if he plays golf with him, he must beat him. He plays golf with him. Therefore, if Jones expects to gain Browns respect, he must beat him in golf.

$[\{[p \supset (q \supset r)] \cdot q\} \supset (p \supset r)]$ CKCpCqrqCpr

An examination of these cases reveals that there are only three differences between these two notations. First, they differ in the symbols used for the connectives i.e., "and," "or," "if..., then," which correspond to the operations of conjunction alternation and implication. Polish notation uses capital letters for the connectives "K" for "and," "A" for "or" and "C" for "if...,then." The Peano-Russell Notation uses special symbols for them; '·' for "and" 'v' for "or" and '⊃' for "if...,then." Second they differ in the position occupied by the connective symbols. The connective symbol in the Polish notation is always to the left of that which it connects. It is always between what it connects in the Peano-Russell notation. The paradigm case for Polish is '$\phi\alpha\beta$.' Where ϕ stands for any one of the basic connectives α, β stand for the sentence variables. The paradigm for the Peano-Russell can be given as $\alpha\phi\beta$, where ϕ stands for any one of the basic connectives and α, β stand for the sentence variables. The third difference has to do with the brackets. The Peano-Russell Notation, unlike the Polish, requires the use of brackets. This can best be appreciated by considering "$p \supset q \supset r$." As it stands we don't know whether it symbolizes "If p then if q then r" or "If if p then q then r." By using brackets we can make the distinction. The former is written as $[p \supset (q \supset r)]$; the latter is written as $[(p \supset q) \supset r]$. In Polish the former is written as CpCqr; the latter is written as CCpqr. (Note: Polish notation is also referred to as Lukasiewicz notation since he was largely responsible for its development.)

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*1 and 3 are complex sentences; 2 and 4 are arguments.

**P-R means Peano-Russell.

Fig. 4. Differences between Peano-Russell and Polish notation in symbolizing English sentences and arguments.

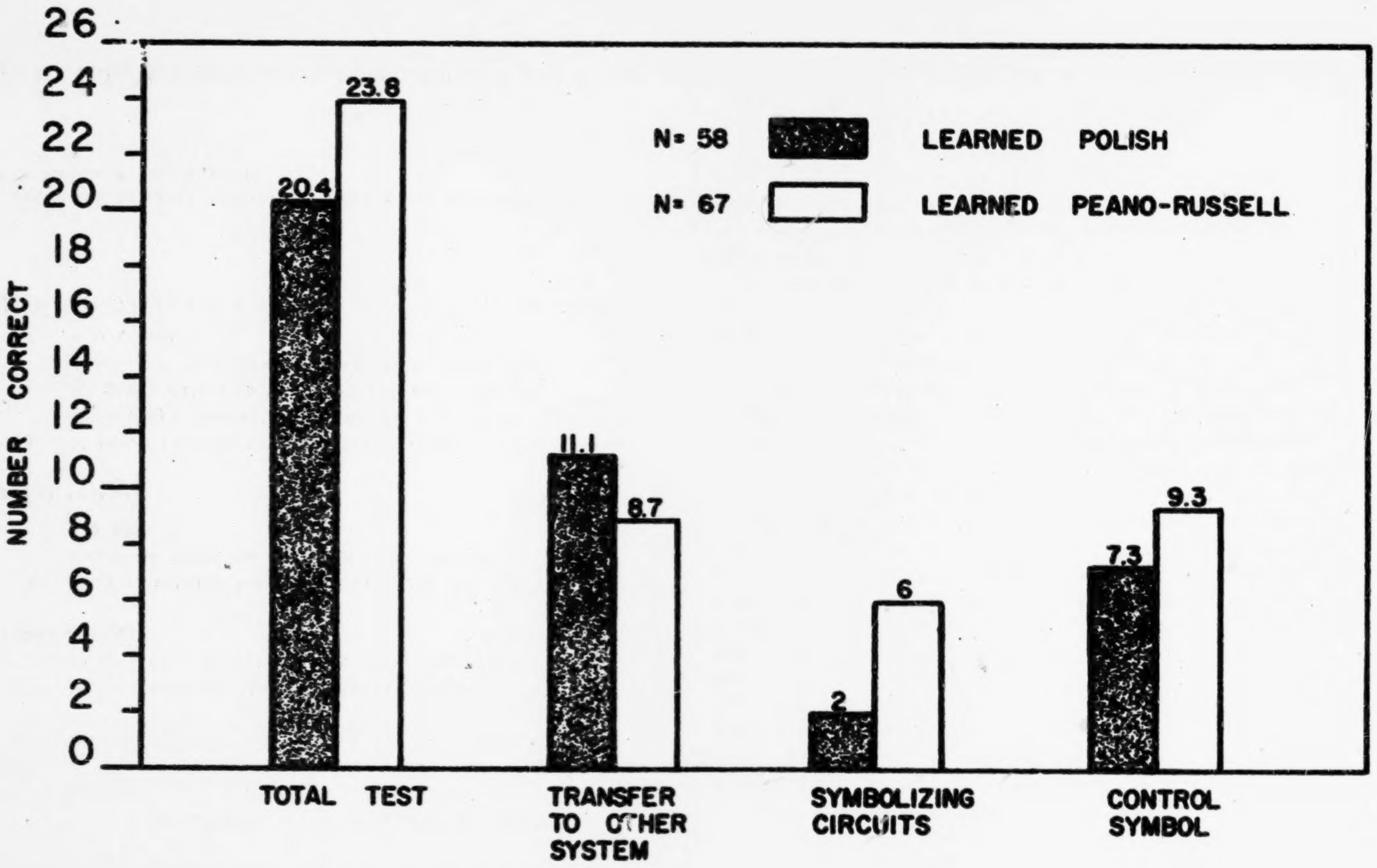

Fig. 5. Mean number correct on total transfer test and subtests for students who learned the Peano-Russell or Polish notational system.

Appendix A

Item Characteristics of the Syllogism Test Used in the Second Study (The Implications of Training in Logic for Incongruity and Atmosphere Effects).

Concrete Items in Which Atmosphere Choice is Incongruent

Item number	Mood[a]	Alternative				
		a	b	c	d	e
2	OE	c	-c	c	-c	x
9	EI	c	-c	c	-c	x
18	OE	c	-c	c	-c	x
20	IO	c	-c	c	-c	x
28	AO	c	-c		-c	x
31	OA	c	-c	c	-c	x
35	IE	c	-c	c	-c	x
38	OA	c	-c	c	-c	x
39	IO	c	-c	c	-c	x
40	IE	c	-c	c	-c	x
42	EO	c	-c	c	-c	x
43	EI	c	c	c	-cx	
44	AE	c	-c	c	-c	x
45	AE	c	-c	c	-c	x
49	AA	-cx	c	-c	c	
54	EO	c	-c	c	-c	x

Concrete Items in Which Atmosphere Choice is Congruent

Item number	Mood[a]	Alternative				
		a	b	c	d	e
48	OE	-c	c	-c	c	x
1	EI	-c	c	c	c	x
15	OE	-c	c	-c	c	x
12	IO	-c	c	-c	c	x
24	AO	-c	c	-c	c	x
22	OA	-c	c	-c	c	x
12	IE	-c	c	-c	c	x
10	OA	-c	c	-c	c	x
17	IO	-c	c	-c	c	x
52	IE	-c	c	-c	c	x
27	EO	-c	c	-c	c	x
14	EI	-c	c	-c	cx	
5	AE	-c	c	-c	c	x
37	AE	-c	c	-c	c	x
8	AA	cx	-c	c	-c	
23	EO	-c	c	-c	c	x

Note: -- c=congruent conclusion; -c=incongruent conclusion; x=correct conclusion; underlined letters indicate atmosphere prediction.

[a] A=All X are Y; E=No X are Y; I=Some X are Y; O=Some X are not Y.

Abstract Items

Item number	Mood[a]	Alternative				
		a	b	c	d	e
36	OE				_	x
16	EI				_	x
29	OE				_	x
7	IO				_	x
19	AO				_	x
4	OA				_	x
11	IE				_	x
41	OA				_	x
46	IO				_	x
50	IE				_	x
13	EO				_	x
25	EI				x̲	
30	AE		_			x
33	AE		_			x
26	AA	x̲				
53	EO				_	x

Note: -- x=correct conclusion; _=atmosphere prediction.

[a] A=All X are Y; E=No X are Y; I=Some X are Y; O=Some X are not Y.

Appendix B

Item Characteristics of the Syllogism Test Used in the Third Study (The Separate and Joint Effects of Congruity and Atmosphere).

The following groups of items are divided as follows:

Group I. Both atmosphere and congruity hypothesis predict that the syllogism will be called valid.

Group II. Only the atmosphere hypothesis predicts the item will be called valid.

Group III. Only the congruity hypothesis predicts the item will be called valid.

Group IV. Neither hypothesis predicts a choice of valid.

The item number is given first, then the mood[a] of the syllogism (all in Fig. 1).

Group I	Group II	Group III	Group IV
3. IEO	9. AEE	2. OAI	1. IEE
5. OEO	12. EOO	4. EOA	6. IOA
7. EOO	14. IEO	11. AEA	8. AOI
10. IOO	15. OEO	13. IOA	16. AEI
19. IEO	25. IOO	17. IOI	18. EOA
21. EOO	26. IOO	20. IEE	23. AEA
22. AEI	29. AEE	24. OEO	27. IEI
31. AEE	33. OAO	28. OEA	34. EOE
35. AOO	44. EOO	30. IEI	36. OEE
37. AEE	45. AOO	32. OAE	38. AEO
39. OAO	49. OEO	41. EOE	40. OAI
42. OAO	53. AEE	47. OEE	46. IOI
43. AEE	55. IEO	52. AOI	48. OAE
50. IOO	56. OAO	54. AEA	51. OEA

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[a] A=All X are Y; E=No X are Y; I=Some X are Y; O=Some X are not Y.

The Teaching of Pronunciation of Russian Words on SOCRATES

Reference: Lippert, H. T. The teaching of pronunciation of Russian words by programed instruction using SOCRATES, a computer-based instructional system. Projected doctoral dissertation, University of Illinois, 1966.

Status: Completed.

Type of Study: Experimental.

Problem:

(1) To assess effects of four programed instructional sequences in learning, retention and transfer of Russian words. (Program of prompting and confirmation)

(2) To assess effects of choice of a task parameter on subsequent performance. (Bite choice)

(3) To assess the differences in learning, retention and transfer due to learning the same materials in various orders given by assignment. (Bite order given)

(4) To determine the interactions present.

(5) To determine the aptitude correlates of performance under the different conditions of learning and transfer.

Materials:

(a) Three lists of Russian words balanced in terms of stimulus and response characteristics, contained in SOCRATES film #20.

(b) A list of Cyrillic characters and their phonic element counterparts with associated instructions to memorize.

Materials(cont'd): (c) Apparatus required is the SOCRATES computer-based instructional system.

Subjects: A minimum of 90 college students with no prior knowledge of Russian is required for a complete assessment of experimental variables.

Procedure: (a) One design is 4 x 3 x 6 (Program x Bite Choice x Bite Order Given); a second uses Group 5 as a control condition.

(b) The four treatment groups will be:

Group	Strategy
1	1-2-2
2	1-2-3
3	1-3-3
4	1-3-2
5	memorization of phonic elements

where Strategy 1 is Prompting,

Strategy 2 is Confirmation with cue present,

Strategy 3 is Confirmation with cue absent.

(c) Time, errors, recognition, differentiation of sounds of individual letters out of context, generalization (transfer) to identification of correct pronunciation of words not taught will be measured.

The Implications of Training in Logic for Incongruity and Atmosphere Effects

Reference: Stolurow, L. M., Frase, L. T., and Suh, D.

Status: Completed.

Type of Study: Experimental.

Problem: In a syllogistic logic, formal words determine two specific characteristics of a categorical proposition, its quality and its quantity. The quality of a categorical proposition is either affirmative or negative; the quantity of a categorical proposition is either universal or particular. According to the atmosphere hypothesis, the quality and quantity of formal words (quantifiers) in the premises of a syllogism create an atmosphere which influences the conclusion that students will draw. The full statement of the atmosphere hypothesis is:

> "The atmosphere of the premises may be affirmative or negative, universal or particular. Whatever it is, according to the hypothesis, it creates a sense of validity for the corresponding conclusion." (Woodworth and Sells, 1935).

> "In general formulation the secondary hypotheses suggested for application to syllogistic reasoning are (1) that a particular premise creates a some atmosphere, even though the other premise be universal, and (2) that a negative premise creates a negative atmosphere even though other premise be affirmative."
> (Woodworth and Sells, 1935)

Woodworth and Sells deliberately chose the symbolic or abstract (e.g., all A is B), rather than the concrete form (e.g., all mothers are bad) of syllogism on the grounds that semantic influence would be a confounding factor in their design. The purposes of this experiment were (1) to determine whether the atmosphere effect holds for logically-trained as well as logically-naive students when given either linear or branching programs; (2) to determine whether there are negative effects from language habits to formal syllogistic reasoning; (3) to replicate results of atmosphere experiments (Woodworth and Sells, 1935; Sells, 1936); and (4) to determine the utility of using semantic differential word ratings (Osgood, Archer, and Miron, 1962) in predicting the acceptability of syllogistic conclusions which contain congruent or incongruent semantic terms.

Hypotheses. The following hypotheses were: (1) gains in scores on a syllogistic reasoning test will differ following learning from a linear and/or a branching program, (2) a negative transfer effect in the learning of formal syllogistic reasoning will occur as a result of the established language habits of the students, (3) the Woodworth and Sells (1935) experiment can be replicated with the present materials, (4) the atmosphere effect does not hold as well after training in logic as it does before training has been received, and (5) the atmosphere effect embraces concrete forms where congruent or incongruent semantic terms are used in the syllogistic conclusion.

Materials: Syllogistic tests and a logic program, both linear and branching form. The program forms are identical to those used in the first study. The syllogistic reasoning test was used presenting congruent and incongruent decisions. There were 48 five-choice syllogisms matched as to mood and figure: 16 in abstract form, 16 in which the conclusion (predicted by the atmosphere hypothesis) was congruent semantically, and 16 in which the predicted conclusion was incongruent semantically. For any particular mood of a syllogism there were alternative decisions which either were congruent or incongruent and were predicted (or not) by the atmosphere hypothesis.

Subjects: One hundred and nine introductory logic students from four classes at the University of Colorado.[2] Data from 62 students (42 men, 20 women students) were analyzed.

Procedure: The independent variables investigated included the presentation form of the logic program (linear, branching) and the form of the items on the syllogistic reasoning test (congruent, incongruent). The three program forms were identical to those used in the immediately-foregoing study.

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[2] Provided by the instructor, Dr. Donald Roberts, who cooperated in and collected data for this study.

Congruency and incongruency were designed operationally in terms of the evaluative scores of nouns secured from English-speaking students by means of the semantic differential (Osgood, Archer, Miron, 1962). An incongruous conclusion (all mothers are bad) is composed of a positive assertion (all . . . are . . .) between a noun (mother), which is rated very high on the evaluative scale, and an adjective (bad), rated very low. The conclusion (all mothers are good) would be considered congruent (Osgood, Suci Tannenbaum, 1956).

Abstract syllogisms provided a base line for comparison to determine syllogistic effects.

Findings:

Comparison of Linear and Branching Programs

There were no differences between the maximum linear, minimum linear, and branching programs on any of the dependent variables including the syllogism test.

The interrelationship of performance measures under the three program conditions remains essentially the same as in the earlier study. In this study there was no analysis of application and knowledge items, nor was a review test included.

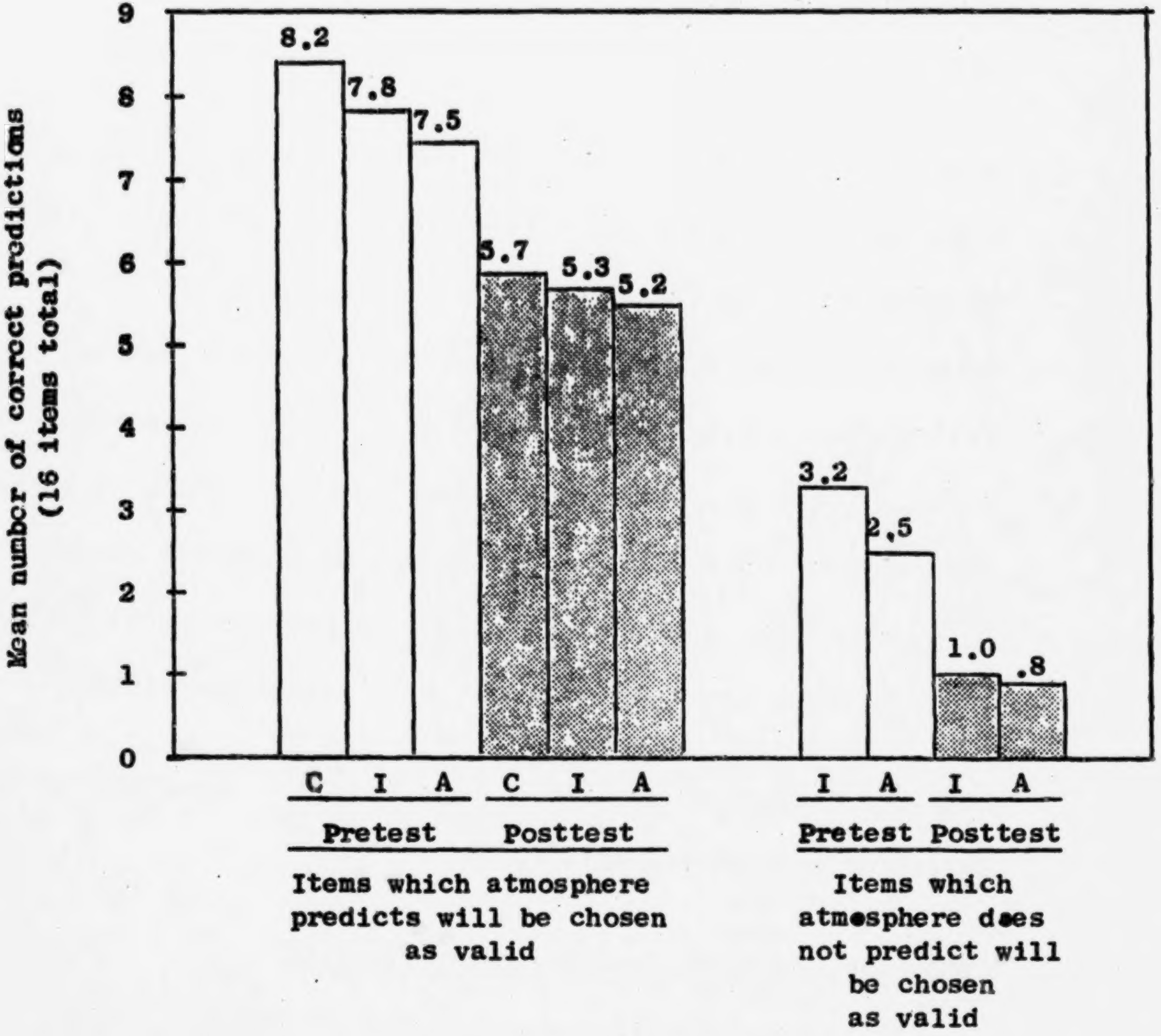

Fig. 1. Summary for Experiment 3 of Predictions Correctly Made on the Basis of Atmosphere for Concrete-Congruent Items (C), Concrete-Incongruent Items (I), and Abstract Items (A) on Pre- and Posttests.

Findings (cont'd.): **Atmosphere and Congruity Hypotheses**

Fig. 1 summarizes the results of the present study and indicates the absolute and relative number of choices for the various alternatives.

Atmosphere choices. Fig. 1 shows that the absolute number of choices successfully predicted by the atmosphere hypothesis (about 8) exceeds the absolute number of choices predicted successfully by the congruity hypothesis (about 3). The probability of each choice is only .2 in the former case and .4 in the latter. The probability of the number of choices being as great as it was for both correct choices and choices predicted by semantic congruity is at the chance level while the same probability for the atmosphere hypothesis is beyond the .02 level. Fig. 1 shows that choices of congruent alternatives were more numerous than choices of incongruent alternatives. Both were more numerous than choices of matched abstract alternatives. In confirmation of the hypothesis offered by Woodworth and Sells (1935) it can be said that it is possible to predict that students will tend to find certain conclusions to be valid when, in fact, they are invalid.

The present study provided a somewhat modified test of the atmosphere hypothesis since *Ss* actually may choose between several alternative conclusions. In Sells' experiment, *Ss* were required to choose between "absolutely true", Findings (cont'd.): "probably true", "absolutely false" and "does not follow".

Table 10 summarizes the results of the analysis of variance on the number of atmosphere choices. The results clearly show that the atmosphere effect was reduced sharply after experience with the logic materials. Since Ss were not given feedback about their responses on the pretest, improvement on the posttest (by virtue of pretest experience) should have been minimized.

Both of the main effects of the analysis of variance are significant. It is interesting to note that more atmosphere choices (all but two of these were incorrect) were made for the concrete items. Also, that the order of congruent and incongruent items is in the predicted direction (people are likely to accept an invalid conclusion if the conclusion makes a positive statement about something they consider good, or if it makes a negative statement about something they consider bad).

Aside from statistical indication that some people tend to perform better on one test condition than on another is the suggestion that Ss respond differently to the concrete and abstract items (significant interaction, $p < .05$).

The number of erroneous judgments that reveal the difference of the atmosphere effect is at the chance level on the posttest. A difference in the atmosphere effect between concrete and abstract items was found.

Table 10

Analysis of Variance on the Number of Atmosphere Choices on Pre and Posttest for Congruent, Incongruent, and Abstract Test Items

Source	MS	df	F	P
Pre-Post Tests (P)	551.63	1	48.05	<.001
Concrete-Abstract (C)	12.42	2	5.72	<.01
Subjects (S)	16.30	61		
Interactions:				
P x C	.74	2	7.65	<.001
P x S	11.48	61	1.45	<.05
C x S	2.17	122		
C x S x P	1.50	122		

Findings (cont'd.): Congruent choices. In absolute numbers, the choices successfully predicted by the congruity hypothesis (when opposed to the atmosphere predictions) are quite low. Two choices on each item are predicted by the congruity hypothesis and, hence, the probability of a correct prediction is .4 for each item; yet the average number of correct predictions is less than three on the pretest, and less than one on the posttest. The low number of predictions indicates that the semantic context of the conclusions may not be a powerful factor in determining Ss responses relative to the atmosphere effect. The items from which this information was drawn, however, include only those in which a congruent choice would mean a choice contrary to the atmosphere hypothesis.

Table 11 summarizes the analysis of variance relating the number of predictions correctly made by the congruity hypothesis. Once again there is a large difference in pretest and posttest performance--a decrease in the number of congruous choices. Interaction effects between the concrete-abstract levels and Ss are not statistically significant. Interaction between pretest-posttest and Ss indicates individual differences in the effects of congruity before and after training in logic.

An interesting point to note is that, on the posttest, the absolute number of choices predicted by semantic congruity was below chance ($p < .006$), while the number of choices predicted by the atmosphere hypothesis was at a

Table 11

Analysis of Variance on the Number of Congruent Choices on Pre and Posttests for Concrete and Abstract Test Items

Source	MS	df	F	P
Pre-Post Test (P)	222.68	1	51.42	<.001
Concrete-Abstract (C)	12.20	1	6.52	<.02
Subjects (S)	5.41	61		
Interactions:				
P x C	4.94	1		
P x S	4.33	61	2.69	<.001
C x S	1.87	61		
C x S x P	1.61	61		

Findings (cont'd.): chance level. Both factors seemed to decrease in importance at about the same rate (slopes of lines). The number of correct choices is well beyond the chance level on the posttest, but the fact that 32 per cent of the items were incorrect indicates the difficulty level of the test.

Correct choices. Fig. 2 summarizes the substantial difference in the number of correct choices for the concrete and the abstract items. In confirmation of the Woodworth and Sells (1935) and Wilkins (1928) data, more correct choices are made with concrete items.

Table 12 summarizes the analysis of variance for the number of correct choices. The advantage of concrete over abstract items is beyond the .001 level, as is the difference between pretests and posttests. The lack of interactions seems to indicate there were few differential effects of concrete and abstract items although there were such effects for atmosphere choices. While there were no differential effects of test levels for correct choices, there were such effects for congruent choices and atmosphere choices. Since most of the correct choices were "none of the above", people who tended to be affected by semantic and atmosphere effects should have shown the greatest amount of improvement with experience in logic. Hence, there is an interaction of *S*s with test conditions under the two analyses in which the determining factors were nonlogical. From these analyses one might say that people arrive at correct responses in the

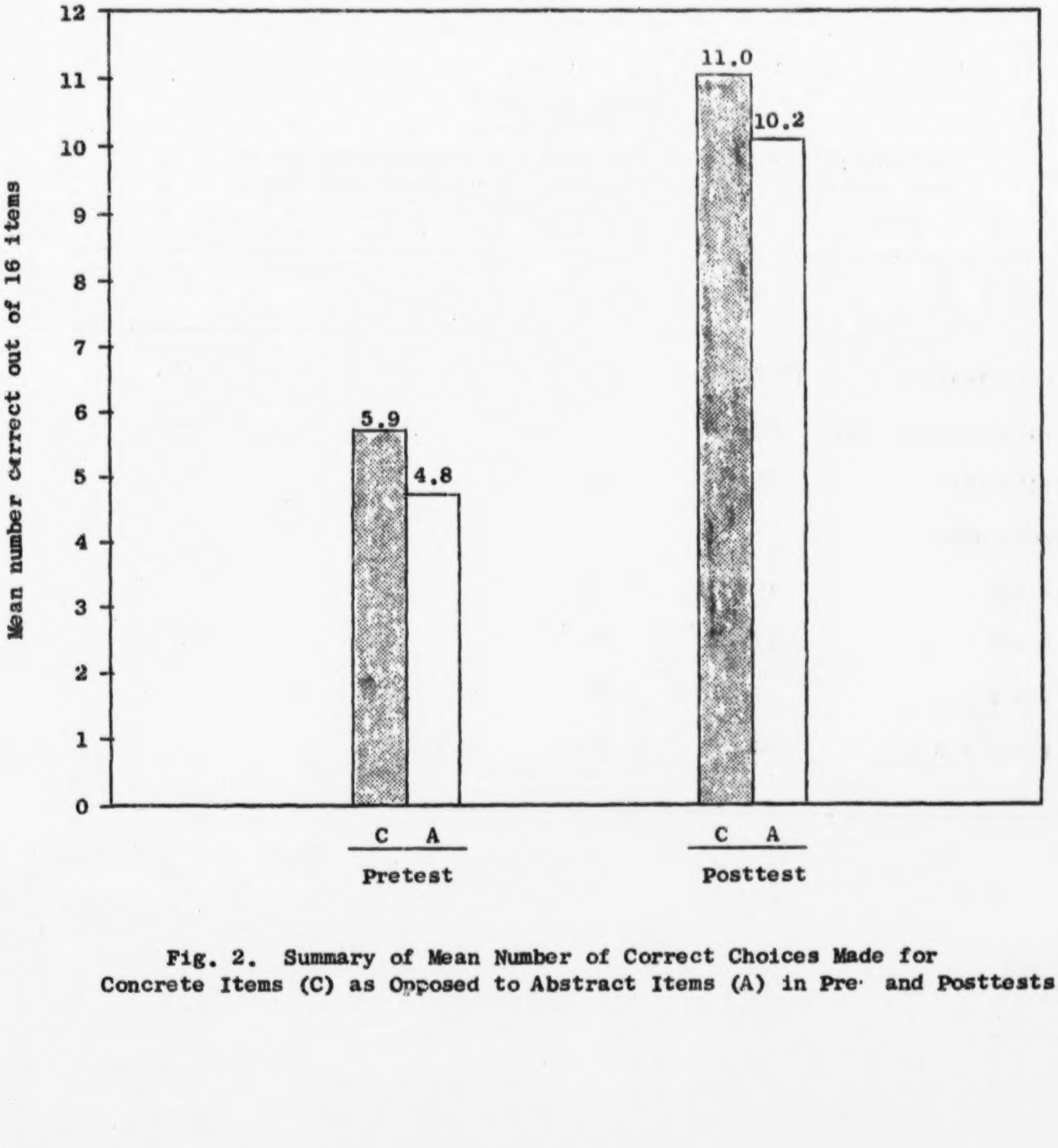

Fig. 2. Summary of Mean Number of Correct Choices Made for Concrete Items (C) as Opposed to Abstract Items (A) in Pre- and Posttests.

Table 12

Analysis of Variance on the Number of Correct Choices on Pre and Posttests for Abstract and Concrete Test Items

Source	MS	df	F	P
Pre-Post Tests (P)	1698.39	1	98.57	<.001
Concrete-Abstract (C)	59.04	1	42.78	<.001
Subjects (S)	31.81	61		
Interactions:				
P x C	10.70	1		
P x S	17.23	61		
C x S	1.38	61		
P x C x S	93.42	61		

same manner, but their choice of incorrect responses reflects their particular dispositions.

Intercorrelations

The correlation of the syllogism test with errors in the program and scores on the logic pretests and posttests relates directly to the theoretical orientation of previous research on the development of learning sets by Bass, et al. (1962).

Tables 13 and 14 present correlations of the total pretest and total posttest with the parts of those tests. It can be seen that, in all cases, the concrete items correlate higher than the abstract items with total scores and that the relative differences, especially concerning atmosphere choices, are reduced under the posttest condition. In addition, the incongruent items correlate higher than congruent items with total scores on the pretests and posttests. This suggests the importance of verbal fluency in reasoning, confirming the findings of Sells in that respect.

Comments:

1. There were no differences that could be related to linear or branching programs on any dependent variables.
2. The atmosphere effect does not hold equally before and after training. Training reduces the influence of the atmosphere on reasoning.
3. The Woodworth and Sells (1935) results can be obtained

Table 13

Correlation of Items on the Syllogism Tests With the Total Pretest Score
N=62

Test	Correlation with total pretest scores						
	Congruent choices		Atmosphere choices			Correct choices	
	Concrete	Abstract	Incongruent	Congruent	Abstract	Concrete	Abstract
Pre	-.52	-.18	-.48	-.33	.01	.91	.76
Post	-.31	-.12	-.22	-.16	-.11	.31	.30

Note: -- There were 16 test items for each of the subtests above.

Table 14

Correlation of Items on the Syllogism Tests With the Total Posttest Score
N=62

Test	Correlation with total posttest scores						
	Congruent choices		Atmosphere choices			Correct choices	
	Concrete	Abstract	Incongruent	Congruent	Abstract	Concrete	Abstract
Pre	-.15	-.03	-.17	-.07	.05	.33	.31
Post	-.70	-.34	-.78	-.74	-.61	.94	.93

Note: -- There were 16 test items for each of the subtests above.

Comments (cont'd.): with a five-alternative, multiple-choice format. A significant number of correct predictions of student choices can be made from the atmosphere hypothesis; however, even more correct predictions can be made with concrete, semantically congruous items, or with semantically incongruous items than with abstract items such as Woodworth and Sells used.

4. Using concrete items, the Woodworth and Sells' findings were extended and modified. People accept an invalid conclusion that makes a positive statement about something they consider good, or a negative statement about something they consider bad. This can be interpreted as an additional form of atmosphere effect.

The Separate and Joint Effects of Congruity and Atmosphere

Reference: Stolurow, L. M., Frase, L. T., and Odell, S. J.

Status: Completed.

Type of Study: Experimental.

Problem: To determine whether there is a statistical interaction between two semantic effects -- congruity and atmosphere. This was essentially a replication of the second study except that this one includes congruent items which the atmosphere hypothesis does not predict will be called valid.

Materials: A test was constructed in which there were 56 syllogisms. The S was required to indicate whether each syllogism was valid or invalid. The syllogism test can be divided into four parts: (1) those which both the atmosphere and the congruity hypotheses predict will be called valid, (2) those which only the atmosphere hypothesis predicts will be called valid, (3) those which only the congruity hypothesis predicts will be called valid, and (4) those which neither hypothesis predicts will be called valid.

Subjects: Forty-four students from an introductory logic course at the University of Illinois served as Ss for this experiment.[3]

Procedure: A 2 x 2 experimental design was used in this experiment. The variables were congruity and atmosphere effect.

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[3] Provided by the course instructor, Mr. S. Jack Odell, who assisted in the experiment.

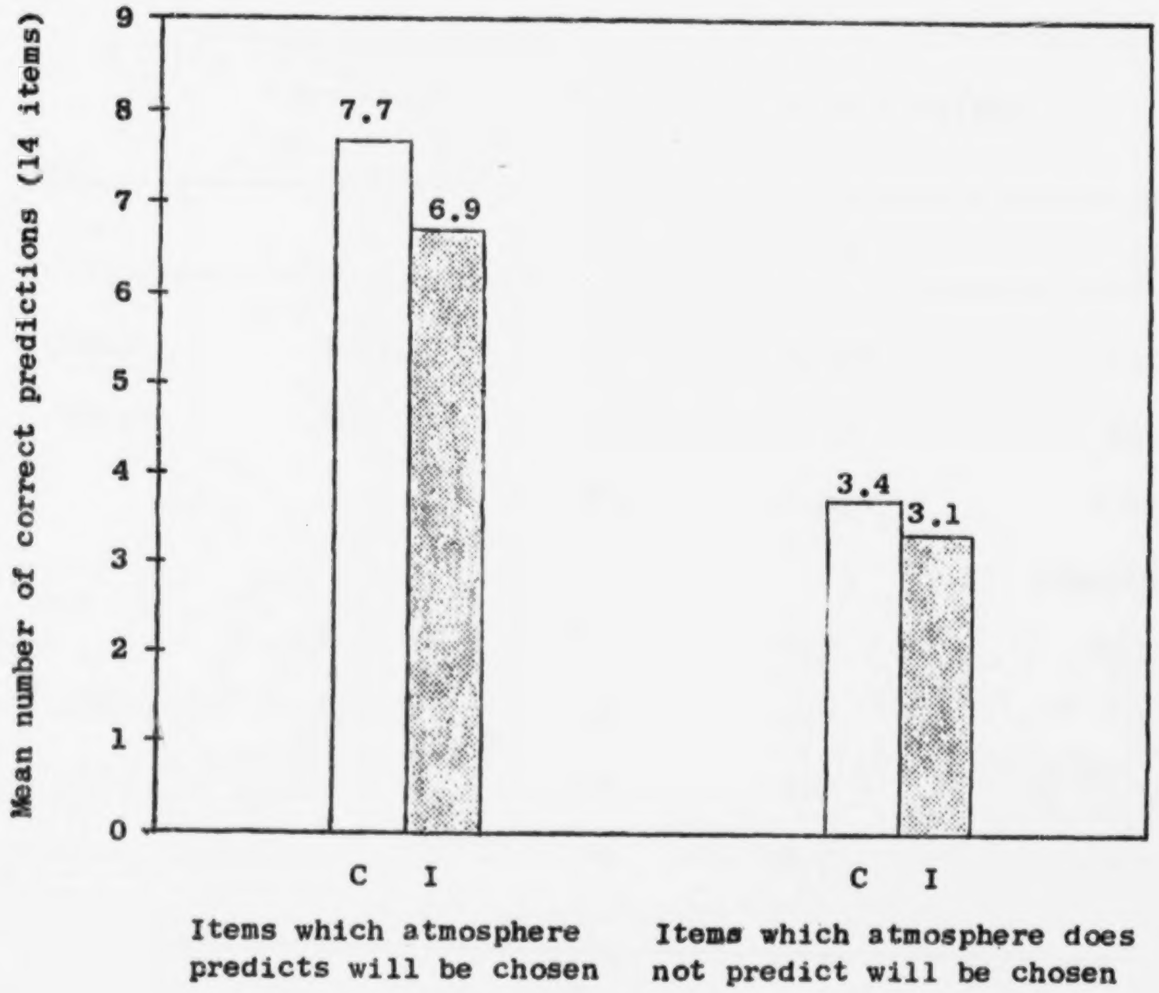

Fig. 3. Summary of Predictions Correctly Made on the Basis of Atmosphere and Congruity (C = Congruent; I = Incongruent).

Note. -- All of these items were invalid, but subjects called them valid.

Table 15

Analysis of Variance on Incorrect Choices

Source	MS	df	F	P
Atmosphere	740.5	1	184.3	<.001
Congruity	11.5	1	7.5	<.01
Subjects	10.6	43		
Interactions:				
A x C	3.0	1	1.6	
A x S	4.0	43	2.1	<.01
C x S	1.5	43		
A x C x S	1.9	43		

Findings: Fig. 3 summarizes the relative and absolute number of incorrect choices for the alternative items.

Table 15 presents the analysis of variance on incorrect choices for the four forms of items. From Table 15 it can be seen that the results of this experiment replicate those of the second study with regard to the relative effects of congruity and atmosphere and of congruous and incongruous terms included in syllogistic conclusions. With the two-choice alternative (valid or invalid), conclusions selected for concrete items on the basis of atmosphere was at the chance level, suggesting the elimination of the atmosphere effect. In addition, Ss exhibited different responses when given atmosphere items,.which is consistent with data obtained by Sells (1936). Responses to congruity differences did not differ across students. There was no statistical interaction between congruity and atmosphere effects.

Abstract of Foreign Language Programs

Reference: Fauser, Christl. Abstract of Foreign Language Programs. Urbana, Ill.: University of Illinois, Training Research Laboratory, U. S. Office of Educ., NDEA Title VII Contract No. 4-20-002, Tech. Rep. No. 7, November, 1965.

Status: Completed.

Type of Study: Survey.

Problem: To obtain information about currently-available foreign language programs so as to determine the approaches taken in teaching foreign languages by means of programed instruction to English-speaking students.

Materials: The following sources were used to identify the programs reviewed:

Modern Foreign Language Teaching. Preprints Part 3. Institut für Kommunikationsforschung, Documentation Division. Berlin: Pädagogische Arbeitsstelle und Sekretariat Pädagogisches Zentrum, 1964.

Hanson, L. F.,(Ed.) *Programs, '63 - A Guide to Programed Instructional Materials Available to Educators by September, 1963.* Center for Programed Instruction; Office of Education, U. S. Dept. of Health, Education and Welfare. Washington, D. C.: U. S. Government Printing Office, 1963.

Hendershot, C. H. *Programmed Learning: A Bibliography of Programs and Presentation Devices.* Saginaw, Mich.: Printing Company, 1964.

Additional information was collected through a questionnaire sent to publishing companies.

Procedure: The programs were described in terms of course objectives, type of program, age group, educational level, uses of tests, aides used and costs.

Findings: A total of 80 programs was surveyed and for 48 programs complete information was received.

SYNTACTICAL FACTORS IN TRANSFER OF TRAINING

In addition to the stimulus factors, syntactical or organizational factors can affect transfer. One concept that relates to the organization of material is the principle of asynchrony (Detambel and Stolurow, 1956). This conception can be expressed as a set of organizational rules relating to the status of the critical and non-critical features of a display. In the transitions from one frame to the next in a program, for example, a critical feature may not change, but a non-critical one may. This is asynchrony without change in the critical stimulus. A second form of asynchronous transition is one in which the critical feature changes, but the non-critical one does not. This is asynchrony with change in the critical stimulus. This conception was the basis for some studies of learning and transfer.

Another way in which sequence is determined is through the use of rules to produce branching. When branching is used, the learner is routed differently depending upon his responses. The route can be determined by a variety of rules, each of which is a statement of a contingency. Branching was studied with a logic program. This study has implications for the methodology of program development and the validity of assertions about remedial branching.

The Effects of Sequence and Structure on Complex Concept Formation

Reference: Davis, D. J. The Effects of Sequence and Structure on Complex Concept Formation. Urbana, Ill.: University of Illinois, Training Research Laboratory, U. S. Office of Education, Contract 2-20-003. Tech. Rep. No. 4, Jan. 1964.

Type of Study: Experimental.

Problem: Since there are several different principles which can be invoked in structuring or sequencing the training trials of a task, it is important to know the transfer effects produced by the different principles. In this study, four groups of Ss were given different training conditions, as specified by four different principles, in order to determine the effects produced in the learning of a transfer task.

Hypotheses.

1. Asynchronous trials result in a higher level of performance.
2. The better order of presentation of training trials is synchronous trials, then asynchronous trials.
3. During the asynchronous trials, it is better to vary the relevant cue first.

Materials: Identical with those used in Study I: a red cross and a green cross represented on a 2.5" x 2.5" square.

Subjects: Eleven subjects in each of four treatments were obtained from an introductory psychology course at the University of Illinois. Participation in the study was part of the course requirements.

Procedure: Asynchrony refers to the relationship between the pattern of stimulus changes from trial to trial. For example, if stimulus element A changes from A to A' in going from Trial 1 to Trial 2, and if element B changes from B" to B, then *both* elements have *changed* on that pair of trials, and may be described as *synchronous*. If element C, however, stayed the same on the two trials, it would have been *asynchronous* with both A and B. Thus, *asynchrony* occurs whenever one element changes from one trial to the next and the other element does not. *Synchrony* occurs whenever both elements change on two adjacent trials, as in the example with elements A and B, and whenever neither element changes on two adjacent trials. Several ways of structuring and sequencing the early trials of a complex task were compared. Four experimental groups received both structured (asynchronous) and unstructured (synchronous) training trials. The asynchronous trials were divided into two segments: A-MAX (the more relevant cue was free to vary) and A-MIN (the less relevant cue was free to vary). The four experimental conditions were generated by the different

Procedure (cont'd): sequential orders of presenting the structured and unstructured trials (A-S vs. S-A) as well as the two types of asynchronous trials (MAX-MIN vs. MIN-MAX). A control group received only unstructured (synchronous) training. The task was the same as that used in Study I. Each *S* was given 160 presentations in five blocks of 32 trials. The design used is presented in Table 1.

Findings: 1. A significant learning effect was found ($F = 24.4$, for 2 and 80 df, $p < .04$). Asynchronous training did *not* result in a significantly higher level of performance. This lack of difference may be due to the lack of generalized learning due to training on only one member of the class of asynchronous blocks and/or the over-emphasis of the less-relevant cue.

2. For the experimental groups, it was found that the presentation of synchronous training trials prior to asynchronous training (Groups 3 and 4 in Table 1) did not improve performance. The hypothesis that this type of training would aid transfer (by familiarizing *S*s with the transfer task prior to asynchronous training) was not confirmed.

3. It was found that presenting a sequence in which the relevant cue varied first (A-MAX condition, Experimental group 2) led to improved transfer task performance

Table 1

Experimental Design and Conditions[a]

Group	N	Trial blocks		
		Training task		Transfer task
		Trials 1-32	Trials 33-64	Trials 65-160
Exp. 1	11	A(MIN-MAX)	S	S
Exp. 2	11	A(MAX-MIN)	S	S
Exp. 3	11	S	A(MIN-MAX)	S
Exp. 4	11	S	A(MAX-MIN)	S
Control	11	S	S	S

[a] S = synchronous or structured training.

A(MIN-MAX) = asynchronous or unstructured training in which the less relevant cue was free to vary during the first 16 trials of a trial block and the more relevant cue was free to vary during the last 16 trials of a trial block.

A(MAX-MIN) = asynchronous or unstructured training in which the more relevant cue was free to vary during the first 16 trials of a trial block and the less relevant cue was free to vary during the last 16 trials of a trial block.

Findings: **(cont'd.)** (F = 4.4, for 1 and 40 df, $p < .05$). This is an indication that the order of training in a complex task should proceed from the more relevant to the less relevant aspects (Experimental groups 1 and 2).

Comments: The conclusions reached in this experiment will serve as the basis for future investigations. In particular, the following questions are of interest:

1. How does the _type_ of asynchronous training affect transfer? It is expected that asynchronous training, which involves only maximally-pertinent cues, would be superior to that which involves only minimally-pertinent cues.

2. How does the amount of asynchronous training affect transfer? There are several issues here. _First_, there is the question of how much training should be given for each type of asynchronous block (e.g., keeping the cross in a fixed position for a block of trials while the circle varies from column to column). _Second_, there is the question of how many types of asynchronous blocks should be presented for optimum transfer. These two questions relate to the multiple problem, training issue, as discussed by Morrisett and Hovland (1959). _Third_, there is the question of apportioning training among the more-pertinent aspects. Is it better to decrease the amount of training for the less-pertinent aspects of a problem as compared with the

Comments: (cont'd.) more-pertinent aspects? There is some slight evidence that this is the case; a direct test of this hypothesis, however, is necessary before a definite conclusion can be made.

3. How does the order of asynchronous training affect transfer? It was demonstrated in this study that transfer is greater when the more pertinent cue is allowed to vary first. This suggests an order relationship in training based on the relevancy of the aspects; i.e., the more relevant or pertinent aspects should be presented first. This should be demonstrated in the case of three or more aspects, each differing in its relevancy to the solution, before this order effect is accepted.

Effects of Two Different Sequences of Frames in Programed Learning of Mathematics

Reference: Lawrence M. Stolurow, Richard E. Fogle and Carole Fogle

Status: Completed. Technical Report No. 13, June, 1966.

Type of Study: Experimental.

Problem: To compare the effectiveness of two different sequences of programed learning frames and determine the correlates of this performance. The two sequences will differ in degree of asynchrony. The relationship between a relevant and an irrelevant component can be said to be synchronous if both maintain their value, or if both change value from one trial to the next. When a change in value of a relevant or irrelevant component is accompanied by no value change in the other, this relationship may be designated asynchronous (Detambel and Stolurow, 1956).

Materials: Tests and programs. The tests will include an aptitude battery administered by the personnel in "Project Promise," a local project providing a special curriculum for underachievers, to identify and equate students. A pretest (68 items) in programed-learning frame form will be used as both a pretest and posttest. A linear program (632 frames) requiring constructed responses will be used to teach concepts of fractions. It is designed to present the concept of conservation of volume, based on Piaget.

Subjects: Thirty-four fifth and sixth-grade culturally-disadvantaged students [boys and girls enrolled in two Champaign, Ill. (Unit 4) schools, Columbia and Switzer], divided into two groups of 17 each. The 34 youngsters represent a subgroup of "Project Promise" and will be matched on chronological and mental age, sex, race, and socio-economic status.

Procedure: Students will be identified as matched pairs through the ability and aptitude tests. All students will be given the pretest (Booklet I) to determine their beginning levels of relevant knowledge. This testing will be completed within the first 50-minute class period. The first day will consist of a 35-minute period; all other days will involve 50-minute periods during which students will work on the program. At the end of each day the last frame responded to is to be designated by a red line and the date entered in the child's booklet. Experimenters and teachers will issue and collect booklets each day. Immediately upon completion of the last booklet each child will be administered the posttest (Booklet I).

Table 18

Number and Types of Changes from Frame to Frame when Examined in Each of the Two Sequential Orders

Asynchronous Condition A*				Asynchronous Condition B*			
Concept change	Fraction change	Object change	Prompt change	Concept change	Fraction change	Object change	Prompt Change
130	970	245	75	539	794	197	75

Table 19

Pretest Means and Standard Deviations of Correct Responses

Group	Mean	S.D.
Asynchronous Condition A	36.353	11.656
Asynchronous Condition B	35.352	12.484

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*A specification of the precise sequential changes will appear in a later report.

Table 20

Statistical Identification of Subjects

Variable	Asynchronous Condition A		Asynchronous Condition B		Total subjects		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Range
1. Socioeconomic status	41.6	4.86	42.5	4.71	42.06	4.74	35-49
2. C.A. in months	133.0	8.61	132.0	7.30	132.5	7.88	120-147
3. Binet M.A. in months	154.5	13.03	154.4	12.33	154.4	12.50	138-181
4. Mean attitude score	3.8	.72	4.0	.56	3.9	.65	2.4-4.8
5. Program performance time in minutes	373.6	69.19	313.2	56.23	343.4	69.23	220-555
6. CTMM verbal standard score	+.385	1.32	+.409	.97	+.397	1.14	-1.625 to +3.813
7. CTMM non-verbal standard score	-.358	1.21	+.084	1.19	-.136	1.21	-2.250 to +2.313
8. CTMM total standard score	+.047	1.13	+.232	.873	+.140	1.00	-2.000 to +2.000
9. ITBS word meaning	43.9	13.71	39.2	13.20	41.5	13.47	27-88
10. ITBS paragraph meaning	41.4	12.80	37.5	13.84	39.4	13.28	21-77
11. ITBS spelling	46.6	15.57	44.5	17.29	45.5	16.24	20-88
12. ITBS language	36.9	19.30	36.7	14.75	36.8	16.91	22-85

Page 2 of Table 20

Statistical Identification of Subjects

Variable	Asynchronous Condition A		Asynchronous Condition B		Total subjects		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Range
13. ITBS arithmetic computation	42.4	9.28	39.5	13.55	41.0	11.52	26-71
14. ITBS arithmetic concepts	41.6	15.30	41.4	17.22	41.5	16.04	25-68
15. Stanford vocabulary	20.5	8.74	21.5	9.71	21.0	9.11	5-41
16. Stanford comprehension	33.5	12.56	33.5	11.44	33.5	11.83	5-60
17. Stanford spelling	22.4	12.62	23.2	10.96	22.8	11.65	3-42
18. Stanford map reading	13.5	3.26	13.4	4.18	13.4	3.70	6-21
19. Stanford graphs	9.5	5.05	8.5	3.64	9.0	4.37	2-18
20. Stanford use of reference	24.1	10.6	26.7	11.17	25.4	10.82	7-44
21. Stanford (18, 19, 20) total	47.1	16.59	48.5	15.64	47.8	15.90	15-74
22. Stanford arithmetic concepts	16.9	8.23	18.1	5.73	17.5	7.01	4-36
23. Stanford problem solving	11.1	5.54	10.4	3.54	10.8	4.60	1-25
24. Stanford total arithmetic	28.1	12.86	28.5	8.39	28.3	10.70	5-61

Table 21

Means and Ranges of Binet IQ Scores for Schools in Study

	Columbia School	Switzer School	Total subjects
Mean IQ	113.6	113.6	113.6
IQ range	99-133	103-129	99-133

Table 22

Means and Ranges of Binet IQ Scores for Experimental Groups

	Asynchronous Condition A	Asynchronous Condition B	Total subjects
Mean IQ	113.2	113.9	113.6
IQ range	99-127	101-133	99-133

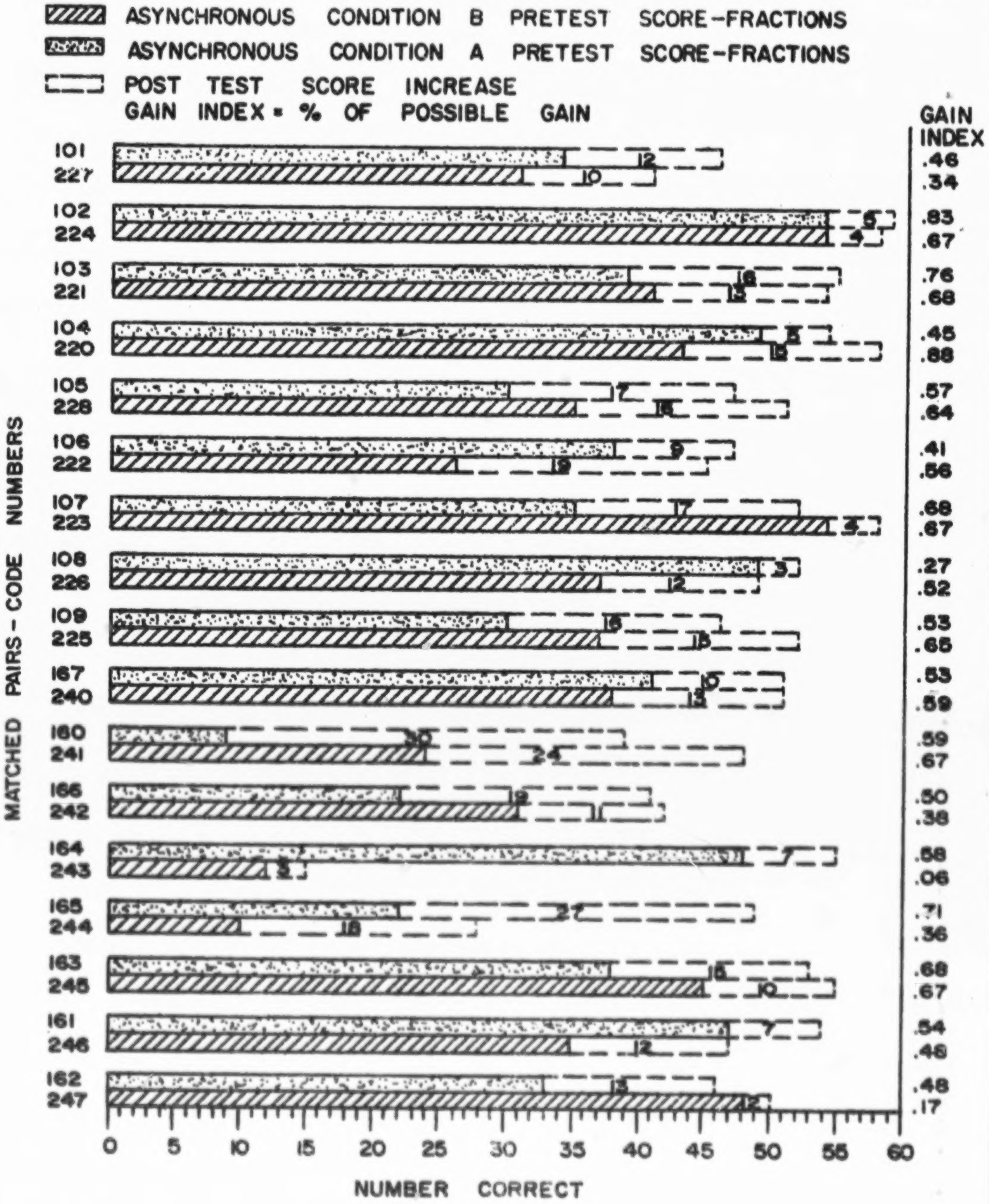

Fig. 6. A comparison of treatments of matched pairs of fifth and sixth-grade students in the Columbia and Switzer Elementary Schools (Unit 4, Champaign, Ill.) under "Project Promise".

Findings: The two sequences produced significant gains in learning, but they did not result in mean differences in the amount learned. The two sequences differed significantly, however, in the aptitudes that were required for the gains made by the students. These findings support those of an earlier and similar study by Cartwright (1962). The sequence differences resulted in significantly different correlations between aptitudes and attitudes. They also resulted in differences in the correlations between learning time and socio-economic status of the family. With the sequence higher in asynchrony, resulting primarily from transitions in which no change in concept is accompanied by a change in other variables, the correlation was significantly negative. In other words, the students from the higher end of the socio-economic strata took less time to learn than those who were from the lower end. With the other sequence, the reverse was true.

Learning and Transfer Effects of Linear and Branch Programs in Logic

Reference: Frase, L. T., Stolurow, L. M., and Suh, D.

Status: Completed.

Type of Study: Experimental.

Problem: One purpose of this experiment, which uses a branching, self-instructional program in logic, was to study some of the ways in which the learning of logic transfers to problem solving. For this purpose, problem solving is defined by test items requiring the application of concepts taught by the program. The second purpose was to compare the performance of *S*s who studied the same self-instructional programs while enrolled in courses of different subject matters. The third purpose was to determine the relationships among scores (learning, retention, and transfer).

Hypotheses. The hypotheses were: (1) Different programs (minimum linear, maximum linear, and branching) will produce differences in performance and (2) the additional relevant information provided by the teacher of the logic courses will not produce differences in the performance of *S*s on tests of knowledge and application.

Materials: Tests (including pretest, review test and posttest) and programed learning materials in logic. The pretest included knowledge and application items. Program Booklet I was of a linear self-instructional format. Booklets II and III consisted of three forms: maximum or minimum linear or branch versions of the logic program.

Subjects: A total of 141 Ss enrolled in an introductory course in philosophy were assigned to three groups.[1] Twenty-three students enrolled in a speech course were included for purposes of an additional comparison.

Procedure: The independent variables under investigation, in relation to learning and transfer, were three presentation patterns (instructional strategies) of the logic program. The program and its branches were prepared by having the programer (an experienced teacher) insert additional materials into the program which students read if they made an incorrect response. All Ss took a pretest and then read the material in Book I, after which those in each class were assigned randomly to different versions of Books II and III, respectively. Each S received either a maximum linear, a minimum linear, or a branched version of the program to study. Dependent variables were (1) pretest scores on knowledge and application of logic, (2) errors made in the program, (3) scores on a review test, (4) scores on a posttest of logic, (5) gains made on application items (pretest-posttest differences), and (6) gains made on knowledge items (pretest-posttest differences). In addition to (5) and (6) above, two measures of gain were used: (a) pretest-immediate posttest, and (b) immediate posttest-delayed. Four weeks after they worked on the program, a delayed posttest was given to approximately one-half of the students in the philosophy classes, and all of the students in the speech class.

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[1] The N of subjects changes slightly due to students who were absent at various points in the experiment.

Findings:

Comparison of Linear and Branching Programs

Analyses of variance indicated there were no significant differences on pretest measures of logic performance or on any of the dependent variables obtained after learning between groups who used either the branching, maximum linear, or minimum linear programs. Data indicate the groups performed equally well with all three of the programs, which raises serious doubts about the ability of even experienced teachers to judge the effectiveness of remedial materials.

Comparison of Speech and Logic Classes

Pretests of logic indicated the speech class initially did not differ significantly from the logic classes. In fact, all groups were comparable initially (see Table 1).

Findings (cont'd.) The speech class, however, was significantly lower than the logic class on the posttest of logic (both knowledge and application items).

Although all groups learned, the speech students learned less than the logic students. The first-named were significantly lower in the amount gained (posttest minus pretest scores), but only on the knowledge items. These results are summarized in Tables 1 - 7.

From these results it seems reasonable to conclude that the philosophy classes were superior in their knowledge of logic. This result can be attributed to class experience in logic beyond the subject matter of the programed logic texts. The significant differences in knowledge, without commensurate gains in performance on application items, indicate that although students in logic may gain more in knowledge of the subject matter with which they deal in class, logic students do not necessarily make superior gains (relative to groups not studying logic) on items which involve transfer (application items).

Intercorrelations

Pretest. The application subtest scores of the pretest were correlated with learning, retention, and transfer measures to determine whether they (1) were equally effective, (2) would predict subsequent performance, and (3) would predict differently under the different learning conditions.

Table 1

Means and Standard Deviations for Logic Pretest Scores

Groups	N	Logic pretest					
		Total		Application		Knowledge	
		M	S.D.	M	S.D.	M	S.D.
Philosophy 1	44	42.89	5.7	28.43	4.6	13.95	2.35
Philosophy 2	47	43.32	5.4	28.84	5.1	14.66	2.54
Philosophy 3	50	42.60	4.7	28.64	4.0	14.26	2.32
Speech	23	43.39	18.7	27.43	12.2	16.21	7.00

Table 2

Means and Standard Deviations for Logic Posttest Scores and Gain Scores

Group	N	Logic Posttest						Gain Scores					
		Total		Application		Knowledge		Total		Application		Knowledge	
		M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Philosophy 1	44	22.57	6.75	29.16	5.06	51.73	3.18	8.02	5.65	.32	4.41	8.52	3.38
Philosophy 2	47	23.09	7.65	28.28	5.45	51.57	3.22	8.84	5.50	-.38	4.36	8.64	4.30
Philosophy 3	50	22.62	6.90	28.76	4.73	51.38	3.21	8.26	5.63	.44	3.75	8.36	3.69
Speech	23	17.22	26.70	23.22	16.30	40.43	12.37	4.30	7.93	1.22	4.76	3.48	3.65

Table 3

Analysis of Variance for the Posttest Knowledge Items

Source	SS	df	MS	F
Between	614.80	3	204.93	6.86*
Within	4780.15	160	29.88	
Total	5394.95	163		

*Significant at .001 level

Group means are in Table 2.

Table 4

Analysis of Variance for the Posttest Application Items

Source	SS	df	MS	F
Between	617.28	3	205.76	3.49*
Within	9432.33	160	58.95	
Total	10049.61	163		

*Significant at .01 level.
Group means are in Table 2.

Table 5

Analysis of Variance for the Total Posttest Scores

Source	SS	df	MS	F
Between	2447.34	3	815.78	5.31*
Within	24573.65	160	153.59	
Total	27020.99	163		

*Significant at .001 level.

Group means are in Table 2.

Table 6

Analysis of Variance for the Gain Scores (Knowledge Items)

Source	SS	df	MS	F
Between	501.27	3	167.09	11.618*
Within	2301.09	160	14.38	
Total	2802.36	163		

*Significant at .001 level.

Group means are in Table 2.

Table 7

Analysis of Variance of Total Gain Scores

Source	SS	df	MS	F
Between	378.67	3	126.22	3.53*
Within	5722.27	160	35.76	
Total	6100.94	163		

*Significant at .001 level.

Group means are in Table 2.

Findings(cont'd.) The pretest application items were better predictors than the knowledge items of the number of errors that the student would make in the program. Ss who earned high scores on application items of the pretest tended to make fewer errors on the program than those who earned low scores (see Table 8).

Immediate posttest: Review test. Errors in the program were more highly correlated with application items on the posttest than they were with the errors in the program. For Book I, the correlation was -.38, for Book II, -.37, and for Book III, -.49 (N = 161). (See Table 8).

Delayed posttest. Errors in the program were more highly correlated with application items on the posttest than they were with knowledge items on the posttest (see Table 9). Application item scores on the posttest tended to be more highly related to errors in the program than were the knowledge item scores on the posttest. This corresponds to the relationship found with the pretest. The correlations of posttest knowledge items with errors in Books I, II, and III were -.40, -.31, and -.32, respectively. The correlations of errors in the program with posttest application items for Books I, II, and III were -.43, -.47, and -.37, respectively (N = 154).

Table 8

Correlations Between Pretest Scores and Errors During Learning and Between Review Test Scores and Errors During Learning

Booklet	N	Total pretest with errors	Knowledge items with errors	Application items with errors	Review test with errors
I	161	-.37 *	-.08	-.43*	-.36 *
II	161	-.40 *	-.23 *	-.37 *	-.37 *
III	161	-.39 *	-.16 **	-.25*	-.49 *

*Significant at .01 level.

**Significant at .05 level.

Table 9

Correlations Between Delayed Posttest Scores and Errors During Learning [a]

Book	N	Total posttest [b] with errors	Knowledge items with errors	Application items with errors
I	154	-.50	-.40	-.43
II	154	-.48	-.31	-.47
III	154	-.41	-.32	-.37

[a] All correlations significant at .01 level.

[b] Correlation between knowledge subtest scores and application subtest scores was .43.

Findings(cont'd.): For the total posttest score following Books I, II, and III the correlation with the number of errors made in the program was -.50, -.48, and -.41, respectively.

These data seem to indicate that a fair amount of the posttest score is associated with errors made during learning, and that the knowledge and application subtests are about equivalent in their relationships to errors made during learning.

Retention test scores. The total retention test score was correlated with the number of errors made in the three booklets; with Book I the correlation was -.32, with Book II it was -.30, and with Book III it was -.47.

The total retention test score also was correlated with the total pretest and posttest scores, .50 and .63, respectively. The retention test was more highly related to application item scores than to the knowledge item scores on both the pre and posttests, in spite of the fact that there were more knowledge items in the retention test. The correlation of the retention test with the pretest knowledge items was .07 ($p > .05$), and with the scores on the pretest application items it was .56. With the posttest, the retention test score on the knowledge items was correlated .41 and on the application items it was correlated .64.

Findings(cont'd.) While the total retention test correlated only .06 with the application items subtest, it correlated .92 with the knowledge subtest. On the posttest, the total score correlation with the application subtest and the knowledge subtest was .90 and .77, respectively. On the pretest, because of variance differences, it can be assumed that both subtests contributed equally.

The knowledge and application items of both the immediate and delayed posttest are supposed to measure the degree to which students know and apply necessary rules. The materials in the programed booklets contain many examples of ordinary language arguments that are application items; this is part of the instruction. As a student goes through the program, he learns a series of rules as well as a series of applications. Since the programs contain a good number of applications, immediate testing that requires Ss to apply rules would most likely yield fairly high scores; specific application items, however, would be difficult to memorize (i.e., there are many semantic contexts involved). It is possible to memorize the rules and the names of propositions, etc., which means that decreased scores on the application subtest (relative to the knowledge subtest) do not represent necessarily a change in the degree to which students are able to apply rules. The decreased application score actually

Findings(cont'd.) may represent a retention decrement for the specific application items contained in the logic materials. In other words, application items on the immediate posttest may not be application items, in the same sense, on the delayed posttest. On the delayed posttest, application items provide a more adequate index of the students' ability to apply rules. In short, the posttest, depending upon its propinquity with the test, may not reveal generalized transfer to application items; rather, the posttest may indicate merely that the student has dealt recently with this type of item.

Correlational analyses of tests. The trends support the findings obtained by Frase (1963), who, in an earlier study using Booklet I of the same self-instructional logic program, found that scores on application items were more related than knowledge items to student performance during learning.

The correlation of the knowledge item test scores with the application item test scores was .16 ($p > .05$) on the pretest; .43 ($N = 157$, $p < .05$) on the immediate posttest; and -.25 ($p < .05$) on the retention test ($N = 57$). The last correlation is especially interesting because it suggests that retention and transfer can be correlated negatively. This could be interpreted to mean

Findings(cont'd.) that students who retained the material best were least able to transfer their knowledge. The retention test total score, correlated with the retention test knowledge items was .92, but the total score correlated with the application items was only .06 ($p > .05$). This difference in the two correlations was obtained in spite of the fact that standard deviations of the two variables were comparable (knowledge items = 3.2, application items = 3.8). This indicates that the delayed posttest score variance was due primarily to application items.

Since the content of each book differs from the other books, the number of errors made on one book tended to have a low correlation with the number of errors made on other books: for Books I and II, $r = .39$; for Books II and III, $r = .55$; and for Books I and III, $r = .36$.

Relationship between pretest and posttest scores. The correlation of pretest and posttest scores was .62. The pretest application items were correlated .62 with the posttest total, while the pretest knowledge items were correlated .23 with the posttest total ($N = 155$). Application items were not only predictors of the errors Ss made in the program but also of the scores Ss made on the posttest.

Findings(cont'd.) The correlation of application items on the pretest with application items on the posttest was .63. The correlation of knowledge pretest scores with knowledge posttest scores was only .24. This suggests that the application items are more reliable than the knowledge items.

A series of studies has been conducted using an imaginary science to examine questions relating to the organization of materials to promote learning and transfer.

In Study I Merrill found that organizational plans suggested by Ausubel's subsumption theory and three other logical alternatives were not differentially effective in producing learning or transfer results.

In a related study, using the same materials, the question was asked whether it is more effective in the learning of hierarchical tasks to require the student to master more basic concepts before he goes on to those which combine or utilize two or more of these concepts. The effectiveness of correction procedure (as it is used to increase rate of mastery prior to proceeding to subsequent phases of the program) is thus determined. The data indicates that this does not reduce the errors made on the retention test but that it does increase the time taken in learning.

In the studies which follow those conducted by Merrill the mechanism of interest is that of mediation under very special conditions: the terms involved in learning two successive serial lists are either (a) unidirectional high frequency associates or bi-directional associates in corresponding serial orders. The suppositions in the verbal learning are: (1) the practice required in the learning of the first list initially elicits the high frequency associates of the stimulus terms and (2) this produces some association of these response terms so that their later deliberate learning takes place more rapidly. The findings of this study will indicate whether unintentional learning does indeed take place by sheer association when the subject is not rehearsing the associates. Both proactive and retroactive effects will be studied using the uni-directional and bi-directional associates.

Another study, one done by Davis, evaluates the factors influencing the "goodness" of strategies used by subjects to reduce uncertainty in their knowledge of certain events. In the first experiment it was demonstrated that the perceptual features of the stimulus materials were influential in determining the student's strategy as long as the resulting strategy did not become inefficient. A second experiment indicated that the efficiencies of strategies decreased with an increase in the number of cards involved in making decisions (increased uncertainty). The third experiment showed that feedback does lead to more efficient strategies and the fourth experiment suggested that transfer does take place along a gradient of generalization.

Learning and Retention Effects of a Model and a Preview in Teaching an Imaginary Science

Reference: Merrill, M. D. Learning and Retention Effects of a Model and a Preview in Teaching an Imaginary Science. Urbana, Ill.: University of Illinois, Training Research Laboratory, U. S. Office of Education, Contract 2-20-003, Tech. Rep. No. 3, Nov., 1963.[1]

Status: Completed.

Type of Study: Experimental.

Problem: Several competing principles concerning the organization of materials to promote learning and transfer exist in education and educational psychology. Programed instruction provides a useful medium for the examination of these principles since they can be used to prepare sequences of frames for comparative study. The effects of each can be determined readily in terms of performance differences of students. This study compares some competing notions about the way to organize complex materials. One program meets the organizational requirements of Ausubel's subsumption theory (1963) and three other logical alternatives were used.

Hypothesis. Based on Ausubel's subsumption theory and its implications for the use of "advance organizers," it

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[1] Based on Master's thesis, University of Illinois.

Problem: (cont'd.) was hypothesized that presenting a model and/or a preview prior to the presentation of complex verbal materials would facilitate the learning and retention of those materials.[2]

Experiment I

Materials: This material included: (1) Section H, a historical introduction which provided a general discussion of the use of the imaginary science; (2) Section M, a description of a model (the model was a guide used in inventing the science); (3) Section D, a summary of the principles and generalizations which were to be learned while studying the science; (4) Section N, a discussion of an aspect of the science and the laws which governed it; (5) Section E, a discussion of a second aspect of the science and its laws and (6) Section P, presented a hypothetical research problem.

Subjects: One hundred twenty eight 10th and 11th grade students from a suburban high school. Their I.Q. scores were known.

Procedure: The subjects were divided into four groups. The C, or conventional, group was given the various learning material sections according to the usual way complex scientific materials are arranged -- H, N, E, P and D. D was a review section. The C group received no advanced organizer.

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[2] Experimental program is on file in the University of Illinois Library under Merrill, M. D. Xenograde systems: An imaginary science, 1964. (unpublished).

Procedure: (cont'd.) Group M received section M (model) as an advanced organizer. It was then given the content sections in the following order: M, N, E, P and D. The third group, P, was given the preview section as an advanced organizer after which it received learning sections H, D, N, E, and P. The final group, MP, received two advance organizer sections, the model and preview sections. It then received the learning sections in this order: M, D, N, E and P. Explicitly, the two variables examined in this study were (1) variation of advance organizers and (2) different orders of presentation of the learning material sections. The presentation of the material was by programed instruction. Immediately after learning the program, half of the subjects received Test A. Two weeks later they received Test B. The remaining half of the subjects received Test B immediately after the program and Test A two weeks later.

Experiment II

Materials: Same as in Experiment I.

Subjects: Twenty-two college juniors and seniors enrolled in a summer session of Educational Psychology.

Procedure: This study compared two of the four conditions used in Experiment I. Ten subjects learned the imaginary science with the program presenting the model and the preview

Procedure: (cont'd.)

section -- the same as group MP in Experiment I. Twelve subjects learned the program without the model and with the review rather than the preview -- the same as group C in Experiment I. The two tests given in Experiment I -- one immediately after learning the program and one two weeks later -- were combined into one for Experiment II, and given immediately following the learning of the program.

Findings:

Results for the two experiments indicated no significant main effects. There were two significant interaction effects: (1) retention as measured by application items was best for high-I.Q. Ss when presented a model, but best for less-gifted Ss when no model was presented; and (2) retention as measured by items measuring taught knowledge was best when no model or preview was presented and poorest when only a model, but no preview, was presented. An analysis of test performance seems to indicate that the teaching-machine program was effective in teaching knowledge of terminology and specific facts but ineffective in teaching understanding necessary for problem solving. It would be desirable to replicate the experiment with a revised program which would enable students to attain a higher level of understanding as measured by problem-solving ability.

Correction and Review on Successive Parts in Learning a Hierarchical Task[3]

Status: Completed.

Reference: Merrill, M. D. Correction and Review on Successive Parts in Learning a Hierarchical Task. In Bertita E. Compton (Ed.), *Proceedings of the 73rd Annual Convention of the American Psychological Association*. Washington, D. C.: American Psychological Association, 1965. Pp. 325-326.

Type of Study: Experimental.

Problem: A common assumption, supported by the theoretical formulations of Ausubel (1963) and Gagné (1965) and the programing techniques advocated by Crowder (1960), is that learning and retention of a hierarchical task are both facilitated by mastering each successive part before proceeding to the next part. On the basis of this assumption it was hypothesized that: in a hierarchical learning task, (a) if part I is mastered, *S*s are able to learn part II faster and with fewer errors than if part I is not mastered before proceeding to part II, etc.; (b) when the terminal test requires every *S* to review previously presented materials until he

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[3] This research was supported by ONR Contract 3985(04), USOE Title VII Contract 2-20-003, and by funds granted by the University of Illinois College of Education.

Problem: (cont'd.) is able to answer every question correctly, Ss who are required to master each successive part of the task before proceeding take less total time to master the terminal test than Ss who proceed from part to part with no requirement of mastery; (c) Ss who are required to master each successive part of the task before proceeding retain the material better than Ss who proceed from part to part with no requirement of mastery even when the terminal test requires every S to review previously presented materials until he is able to answer every question correctly.

Materials: The task used was a complex imaginary science called the Science of Xenograde Systems.[4] Using the rules suggested by Gagné (1965) for generating a hierarchical structure, the imaginary science was analyzed to produce several levels of principles where the principles at one level were extensions, combinations, and interrelations of the principles at lower levels. These principles were then arranged into five lessons, each building on the principles presented in the previous lessons. A quiz was given after each lesson. This quiz was constructed to ascertain whether or not the behaviors specified for each principle in the lesson had

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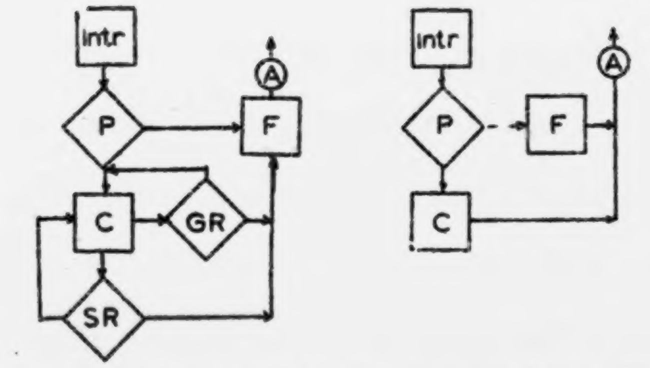
[4] This science was developed by Carl E. Bereiter, Training Research Laboratory, University of Illinois, for use in studying group interaction problems in interdisciplinary research, ONR Contract 1834(36).

Materials: (cont'd.) been attained. Following the five lessons and quizzes was a test section which required Ss to apply all the principles they had learned. A complex computer-based teaching-machine system, SOCRATES (System for Organizing Content to Review And Teach Educational Subjects), was used to present the content of the imaginary science to the Ss. The components of the system are illustrated elsewhere (Stolurow & Davis, 1963).

Subjects: Sixty-two volunteers were recruited from the undergraduate and Master's-level education courses offered during the 1964 summer session at the University of Illinois.

Procedure: The mode of presentation was branching-type programed instruction. Each of the boxes in the flow diagrams in Fig. 1 represents a frame of the teaching program. The presentation frames (P) contained a short passage of material and a multiple-choice comprehension question concerning the passage. If his answer was correct, S was shown a feedback frame (F) which repeated the question, indicated the answer which was chosen, and stated "you are correct." When the S had finished reading the F frame, pushing a ready button presented him with the next P frame. If the answer on the P frame was incorrect, S was shown a correction frame (C) which repeated the question, indicated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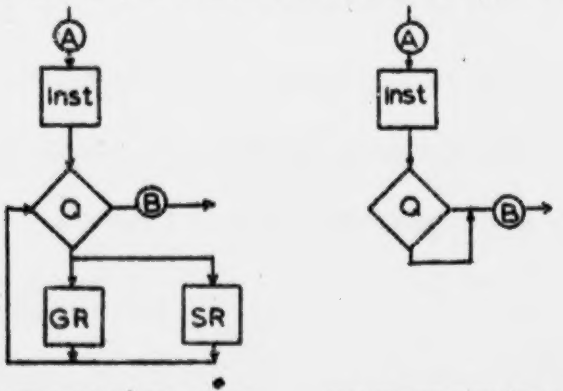
CORRECTION/REV. LESSON NO CORRECT/REV. LESSON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CORRECTION/REV. QUIZ NO CORRECT/REV. QUIZ

Fig. 1. Program flow diagrams illustrating the experimental conditions of correction/review and no correction/review on lessons and quizzes.

Procedure: (cont'd.)

the answer which was chosen, and stated "you are incorrect." When S̲ had finished reading the C frame, pushing a ready button presented him with a general review frame (GR). The GR frame contained summary statements of material which had been covered, and the question that was asked on the P frame was again presented to S̲s. If his answer was correct, he was shown the F frame and then the next P frame. If his answer was again incorrect, he was shown the appropriate C frame and then a specific review frame (SR). On an SR frame the problem was worked out step by step and S̲ was again asked the question. The answer itself was never given but was left for S̲ to figure out. If he still made an error, S̲ was shown a C frame and then the SR frame until he figured out the correct answer, at which time he was shown the F frame and then the next P frame.

Procedure: (cont'd.)

The quizzes were also presented in programed form as illustrated in Fig. 1. If the answer was correct, S was shown the next question frame (Q). If he made an error, he was shown a GR frame. Following the GR frame S was returned to the Q frame. If he made a second error, he was given an SR frame. He was then returned to the Q frame for another try. If he made a third error, he was again shown the SR frame and then returned to the Q frame until he made the correct response.

The test section was arranged in the same way as the quizzes (see Fig. 1). On the Q frame there appeared a Xenograde System table which S was required to complete. Each question asked for a single item of information which required S to apply the principles of the system to arrive at the answer. If S responded correctly he was shown the next Q frame, which showed the answer to the last question in the table. If he made an error, he was shown a general review and if he made a second or third error, he was shown the specific review until he responded correctly. By the time he reached question 68, S had been required to answer each question correctly.

The Ss were randomly assigned to five experimental groups as illustrated in Table 1. Immediately following the presentation of the lessons or summary all groups were presented the test section using the correction/review

Table 1

Experimental Design and Treatment Group

	Quizzes	
Lessons	Correction/review	No correction/review
Correction/review	Group I (N = 14)	Group II (N = 14)
No correction/review	Group III (N = 11)	Group IV (N = 11)

Note: Group V (N = 12) was not shown any of the programed lessons or quizzes but was presented only a set of summary statements.

Procedure: (cont'd.) procedure illustrated in Fig. 1. Three weeks later they were presented the test section using no correction/review illustrated in Fig. 1.

Findings: The first hypothesis indicates that mastery of each lesson should facilitate learning and therefore result in fewer errors and less time to learn on each succeeding lesson. It was assumed that correction/review promotes this mastery. In the main, the Lindquist Type III analyses of variance for errors and time on P frames did not support Hypothesis one. The three-way interaction for errors on P frames seemed to indicate that Ss in Group III (correction/review on quizzes) did make progressively more errors per frame. The hypothesis predicted a similar result for Group IV but this did not seem to be the case. The time data were in opposition to the hypothesis in that both interactions indicated that receiving correction/review caused Ss to take progressively more time per frame. This result seems to indicate that rather than facilitating performance the correction/review procedure tends to make Ss more cautious and, consequently, causes them to spend more time in an effort to get a correct answer and thereby avoid review material.

Hypothesis two suggests that, because of the facilitation due to correction/review, Groups I and II would take less total time to complete the entire task than would

Findings: (cont'd.)

Groups III and IV. The two-way analyses of variance were in direct opposition to the hypothesis. Groups I and II took more time during the learning (time on lessons 1-5); Groups I and II took significantly more total time than did Groups III and IV; and, regardless of the time spent in learning, there was no difference between Groups I through IV in the number of errors made on the test section.

Hypothesis three predicts that those Ss who received correction/review while learning would make fewer errors and take less time on the retention test. The results indicated that those groups which received correction/review on lessons took longer to complete the test, even three weeks after learning, than those Ss who received correction/review only on quizzes or not at all. This finding lends support to the indication mentioned earlier that correction/review on lessons tends to teach Ss to be cautious and, consequently, to proceed more slowly. There was, however, no significant difference in the number of errors.

Group V was a special control group which was included to obtain a measure of the effectiveness of the review material that was used in the lessons. Because this group did not see any of the lessons, but was presented only the set of summary statements which were used for the general review in the lessons, their understanding of the material

Findings:
(cont'd.)

could only be based upon these summary statements and the correction/review procedure common to all groups in the test section. One would expect this group to take longer to complete the test section than the other groups, but that they would take less time to complete the test section than the time required for other groups to complete Lessons 1-5 plus the test section. The comparisons of this control group with the experimental groups indicated that both of these assumptions were true. It would seem logical to assume that this group would also make more errors. The analysis also supported this assumption.

It was observed that _Ss_ in Group V did not make significantly more errors on the retention test than any of the other groups, and that they did not take significantly more time. Apparently the summary statements and review technique used in this study were very effective instrumental techniques. Three weeks after learning, Group V retained as much as any groups, and, considering total time in learning and testing, represented, by far, the most efficient procedure.

An Examination of Human Strategies for Acquiring Information

Reference:	Davis, D. J. An examination of human strategies for acquiring information. Unpublished doctoral dissertation, University of Illinois, 1965. Also Davis, D. J. An examination of human strategies for acquiring information, Urbana, Ill.: University of Illinois, Training Research Laboratory, Tech. Rep. No. 8, U.S. Office of Education, NDEA Title VII, Contract 4-20-002, Oct. 1965.[1]
Type of Study:	Experimental.
Problem:	It is well known that Ss do not always choose the most logical method to solve problems. This is especially true if the problem involves such nebulous factors as probability and the anticipation of chance events. Studies, such as Komorita (1959) and Edwards (1953), have reported consistently a disparity between the objective, maximally efficient problem-solving strategies, as developed, for example, by Von Neumann & Morgenstern, and the strategies employed by the Ss. Since a disparity between objective and subjective estimates existed, attempts were made to resolve this difference. Various theories of "subjective probabilities" and "subjective values" scales have been proposed and some consistency has been achieved, especially in terms of the "expectation values" of chance events.

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[1] Accepted for publication as "Structure of the Environment and Strategies for Acquiring Information. Journal of Experimental Psychology (in press).

Problem (cont'd.): The present study attempted to evaluate the factors which influence the "goodness" of strategies used by the *S*s to reduce the uncertainty in the knowledge of certain events. Since a reduction in uncertainty was achieved by asking questions which could only be answered by either a "yes" or a "no" by the *E*, a quantitative estimate of the "goodness" of a strategy was calculated in analogy to the binary flow of information in electrical switching systems.

Materials: Sets of labeled cards; a circular dial with a rotatable pointer in the center and a circumference divided into regions, each of which corresponded to certain cards.

Subjects: Experiment I: Eight groups were used, each consisting of 9 males and 9 females.

Experiment II: Seven groups of 20 *S*s were used, each consisting of 10 males and 10 females.

Experiment III: Same group as in Experiment II.

Experiment IV: Two groups were formed from the *S*s used in Experiment III by the differential factor of *change* or *no change* in their strategies due to experience. One group consisted of 50, the other of 90 *S*s.

Procedure: Four experiments in all were reported. In each case the *S*s were undergraduate students at the University of

Procedure (cont'd.): Illinois. The procedure was similar in all four experiments in that the S was shown a stack of cards each identified by a letter or number and a fraction, while the E spun a pointer (unseen by the S) on a circular scale with the periphery of the scale randomly marked with the same symbols appearing on S's cards. The periphery, however, was divided in such a fashion that the fraction given on each card represented the probability that the pointer would stop at that particular symbol. Once the pointer had stopped the S had to determine the point by asking E such questions as could be answered by a "yes" or a "no". After the point had been determined the S was given the option of organizing his questions according to the strategy which he considered "best".

The independent variable in each case was the type of deck shown to the S. Decks varied in the proportion of letters to numbers and the total number of cards in the deck.

The dependent variable was the final strategy or the "sequence of questions" as finally chosen by the S. For each strategy a "goodness" index was calculated and these indices constitute the raw data.

Findings: Experiment I: χ^2 and Kruskal-Wallis analysis of variance indicated that the letters or numbers labeling cards were influencial in strategy formation but were retained only

Findings (cont'd.): as long as the resulting strategy did not become too inefficient (p in both tests $< .001$).

Experiment II: χ^2 and the K-W analysis of variance (both $p < .05$) indicated that efficiency of strategies decreased with increasing number of cards and increasing "uncertainty".

Experiment III: A t test ($p < .001$) indicated that experience leads to development of efficient strategies if feedback is allowed.

Experiment IV: Supported the existence of transfer from the learning to the transfer situations and the existence of a gradient of generalization (χ^2 $p < .02$).

Comments: The present study differs from previous ones in attempting to give quantitative interpretation to strategies. It may, however, have minimized the role of motivation, a factor considered by Preston and Baratta (1948) and Becknell (1940).

Mediation in Serial Learning: Experiment I.

Reference: Stolurow, L. M. and Brehman, G. E., Jr.

Status: Completed.

Type of Study: Experimental.

Problem: To determine the effects of the associative relationship between the corresponding words in two word lists in terms of (1) the rate of learning of the second list (proaction), and (2) the recall of both lists following their mastery (retroaction). The study was related to mediational interpretations of transfer by revealing the potential duality of effect which can occur if the terms in two lists are both cues and responses not only *within* lists but also *between* lists.

Materials: The materials consisted of word lists designated as A, B and C. List A contained 10 words which had been used as stimulus terms to elicit free associations. List B contained the word associate given by the students to the A list, and these words were in the corresponding position of their bi-directional associates in the A list. The C list was a control or neutral list whose words were associationally unrelated to those in the B list but equal in difficulty and average syllable length to words in the A list.

Table 2

Experimental Conditions for Learning and Transfer

Experimental Groups				Control Group	
E-1		E-2		C	
List A	List B	List A	List B	List A	List B
10 stimulus words from free association lists	10 response words from free association lists matched as to position across lists	10 stimulus words from List A in E-1 but random in their order	Same 10 response words in same order as in E-1	10 neutral words equated with List A in experimental groups as to difficulty and syllable length	Same 10 response words in same order as in E-1

Subjects: Volunteers from student-teacher sections of Educational Psychology 211 were assigned randomly to the three conditions.

Procedure: Three groups were used. All three learned the same list of words as the second or B list in the transfer task. Group 1 (E-1) learned the A list and they learned the B list. Thus, for them, the words in the two lists, which were bi-directional associates of each other, were positionally opposite one another. Group 2 (E-2) first learned List A and then List B^1. B^1 consisted of the bi-directional associates of the words in List A not in the correponding position. Group 3 (E-3) served as a control condition. These students learned List C and then List B.

Findings: Data indicated that, in contrast to earlier findings in an unpublished study (using uni-directional associates) by Stolurow and Swenson (1949), negative transfer does, in fact, occur. In addition, accuracy of recall was found to be less when the associates were not opposite each other. It was not significantly affected when the associates were placed opposite to one another.

Table 3

Means, Standard Deviations, and Significance Tests for all Groups

Measure	Means			F	H[a]	Standard Deviations			
	E-1 (N=20)	E-2 (N=10)	Control (N=16)			E-1 (N=20)	E-2 (N=10)	Control (N=16)	
List A trials to criterion	13.65	12.60	17.94	2.87	-	5.41	6.65	7.22	1.42
List B trials to criterion	9.65	10.60	7.84	-	10.81*	4.89	3.27	5.66	8.32**
List A accuracy of recall	9.05	5.90	8.56	5.75*	-	2.16	4.35	2.06	3.85
List B accuracy of recall	9.85	9.80	9.87	-	-	0.37	0.63	0.35	-
Errors-actual and potential	2.45	5.00	2.00	3.59**	-	2.58	4.03	2.48	3.56
Inter-list association errors	0.50	0.00	0.00	-	9.20**	0.76	0.00	0.00	-
Intra-list association errors	1.20	2.90	1.12	5.98*	-	1.38	1.79	1.15	2.21

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[a] Kruskal-Wallace H (see Siegel, 1956)

*Significant at the .01 level.

**Significant at the .05 level.

Mediation in Serial Learning: Experiment II

Reference: Brehman, G. E., Jr.

Status: Completed

Type of Study: Experimental.

Problem: There are two purposes of this experiment: (1) to investigate the effect of uni- and bi-directional associations between transfer lists and under improved control conditions and (2) to investigate the question of whether the observed transfer effects are a function of the subjects' awareness of the relationship between the two lists.

Hypotheses:

The hypotheses are:

1. Unidirectional hypothesis: The group under unidirectional association conditions will be superior to any of the control groups with regard to trials to criterion and recall of the second "transfer" serial list, i.e., mediated facilitation.
2. Bi-directional hypothesis: The group under bidirectional association conditions will be inferior to any of the control groups with regard to trials-to-criterion and recall of the second serial list (transfer list), i.e., mediated interference.

3. Mediated interference effects will also characterize any of the experimental groups learning a second "transfer" serial list, the words of which are word associates of the terms in the initial list learned but are not positionally opposite to these terms.

4. Knowledge of the existence of the positionally one-to-one associations will produce interference effects rather than facilitation in the case of both the unidirectional and the bidirectional associates.

5. Replication of the task by each subject, using different serial lists, will result in improved performance for the unidirectional condition and continued interference for the bidirectional subjects.

Materials: Fourteen lists of fourteen words each on negative image slides. Seven lists consisted of the experimental and control lists for the unidirectional condition and seven lists constituted the experimental and control lists for the bidirectional condition. Of the seven lists for either of the two conditions, two were lists containing either unidirectional or bidirectional word association normative responses and two were lists containing the matching stimulus terms in a one-to-one order. The stimulus word lists were designated as $A_1$and $A_2$and the word association response lists described above were designated as lists $B_1$and B_2.

Lists A_1 and A_2 were equated on syllable length and difficulty level (trigram frequencies). Of the seven lists, two more were scrambled versions of lists A_1 and A_2 and were designed to have elements the associates of which are found in list B_1 or B_2 but no longer in positional opposition to one another. The last of the seven lists consisted of a control or A' list which was equal to the A lists described above as to difficulty level (trigram frequencies) and syllable length but which consisted of words known to be incapable of eliciting any strong associations.

Subjects: Ninety-six college student volunteers randomly assigned to experimental conditions.

Procedure: Under either the unidirectional experimental conditions or the bidirectional experimental conditions, each subject learned four lists, two A-B list sets. The second set acted as a replication of the experimental conditions imposed upon the subject during his mastery of the first set. List B was used as one and list B was used as the other B list in the two sets to be mastered by a subject. All subjects learned the same B list; however, the A lists differed depending upon the experimental, or control, condition involved. The following: (1) A-lists the associated responses of which are found in the B-list in a positionally corresponding order; (2) A-lists, the associated responses of which are present in the B-list but not in a corresponding position; (3) A-lists, the elements of which arouse strong associations not in the B list; (4) An A list the elements of which are equal in difficulty to those in lists A_1 and A_2 but are not capable of arousing strong responses. Where the A lists were paired with their positionally opposite B lists, one-half of the subjects were made aware of the existence of the association between the lists and half were not. A criterion of two trials in a row without error was used to determine mastery of a list.

Findings:

1. No mediated facilitation was found when subjects were aware of the relationship. This is in contrast with other findings.
2. No mediated facilitation was found when the conditions were replicated.
3. Significant interference effects were found for the subjects who were aware of the relationship, but these did not persist.
4. No interference effects were found for the subjects who learned a B list, the words of which were associates of the previously learned A list, but not in a positionally opposite sequence.
5. With the bidirectional condition, significantly inferior learning was found for the subjects who were not aware of the relationship between the lists and a trend in the same direction was found for those subjects who were aware.

6. With the bidirectional condition there was significantly poorer learning for the subjects who were aware of the relationship between the two lists when the conditions were replicated.

7. Under the bidirectional condition when there was replication, a marked improvement in the performance of the subjects resulted for the subjects who were not aware of the relationship between the two lists.

8. Under the bidirectional condition performance was not equal for the two groups when they learned the A list making it impossible to analyze the transfer list data.

MEASUREMENT OF TRANSFER

The following study is concerned with determining the conditions to use in assessment of learning and transfer effects. A program in logic was used as one of the instructional conditions; the other was a course in Educational Psychology. Both programed and conventional instruction were used, therefore, in determining the difference between open and closed-book modes of measurement of achievement. The findings indicate that the method of instruction is not related differentially to testing conditions since open-book examination was superior after both types of instruction. Knowledge items appear to discriminate better between subjects who scored well on each type of examination. The correlations with anchor variables indicate that different factors were not involved in successful performance under the two types of examination conditions. Thus it seems possible to assess learning and transfer effects by a single type of instrument without biasing differentially the type of instruction given the students.

Psychological and Psychometric Correlates of Achievement Test Modes

Reference: Marco, G. L.

Status: Completed.

Type of Study: Experimental.

Problem: To (a) discover the differential effect of open and closed-book test modes on mean achievement and to identify psychological factors (affective and cognitive) that account for the difference in achievement; (b) to discover the differential effect of the two achievement test modes on text anxiety; (c) to discover the differential effect of open and closed-book test modes on test variances, reliability, and validity and to identify the psychometric factors that account for the differences. Seven sets of hypotheses were formulated.

Materials: Four 45-minute pre-announced examinations, each consisting of two forms of 20 multiple-choice (primarily four-choice) items, were administered -- three in educational psychology and one in logic. Each test form was comprised of ten knowledge items and ten application items. Each examination in educational psychology covered about six chapters of Cronbach's Educational Psychology (about 200 pages); the examination in logic covered material presented in the first

Materials:
(cont'd)

programed textbook of a three-book series in introductory logic. Subjects were allowed to use the textbook as reference for the open-book examinations.

In addition, an anxiety differential, a measure of specific test anxiety, the Guilford-Zimmerman Temperament Survey and 15 tests from the Kit of Reference Tests for Cognitive Factors were used. There were 34 anchor tests in all.

Subjects:

College seniors in four sections of educational psychology (N = 167) for secondary education majors. Subjects were stratified by section and sex and assigned randomly to four groups.

Procedure:

A counterbalanced design with three 2-level factors: (A) test mode (open, closed), test form (A,B) and order of testing (first, second). Each subject took two of the possible eight treatments in counterbalanced order. Subjects were allowed to use the textbook as reference for the open-book examination. Prior to administration of the four examinations, data were collected on student anxiety, Guilford-Zimmerman, and tests from Kit of Cognitive Factors.

Findings:

The primary results of the study were the following: (a) achievement was consistently better on open-book examinations, (b) knowledge items appeared to discriminate better between

Findings: (cont'd)

subjects who scored well on open-book examinations and those who scored well on closed-book examinations, (c) little difference was found between psychological correlates of examinations under the two test modes. There was some evidence to suggest that an "open" testing situation represented by items that favored the open-book test mode is associated with the same anchor variables as the closed-book examination, but to a greater degree. Variables found to be particularly relevant to achievement were Syllogistic Reasoning, Verbal Comprehension, Induction and Masculinity (negative), (d) there was a tendency for subjects to be less anxious under the open-book test mode, (e) test variances, reliabilities, and validities generally were higher under the open-book test mode, although not in all cases, (f) variables particularly relevant to differences between modes in test variances, reliabilities, and validities were differences in average item variances, test variances, and reliabilities, respectively. This finding was consistent with psychometric literature on the subject. Although differences between subject matters (educational psychology and logic) existed in degree, the findings mentioned above were consistent across subject matters.

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